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The Course of Oil

By K. C. SCLATER

Louisiana's Deep Drilling Operations

The Ninth Midyear Meeting of the American Petroleum Institute is being held this month in New Orleans, Louisiana. The choice of meeting place is an appropriate one. Louisiana is now one of the leading oil-producing states, a position it is likely to retain for many years. It occupies an unique place in the annals of oil development; its coastal area has a greater percentage of deep wells —wells greater than 10,000 feet in depth—than any producing area of similar extent in the world.

Deep drilling has been a prominent subject of discussion in recent years at the Midyear meeting. Because of the proximity of so many deep wells, discussion on that subject this year will have special significance. The standardization program of the American Petroleum Institute, perhaps the most comprehensive project of its kind ever undertaken by any industry, and one of the Production Division's major activities, has been concerned with equipment problems incident to deep drilling. Producers, engineers, and manufacturers, have each contributed to the solution of problems relating to deep drilling machinery and equipment. To this coöperation the industry owes much of the remarkable progress made in the drilling of deep wells. Louisiana's deep drilling operations are the greatest exemplification of this progress.

Studies In Rate Of Penetration

An important item affecting the economy of drilling is the rate at which formations are penetrated by the bit. A study of 500 rotary well records, made to evaluate the factors governing the rate of penetration, reveals that during the past six years drilling speed, or rate of penetration, has increased 120 percent.

The records indicate that the four important factors affecting rate of penetration are: efficiency of the drilling crew, rotating speed of the bit, volume of mud fluid circulated, and the weight carried on the bit. Efficiency of the drilling crew, the records show, influences the rate of penetration most. Rotating speed and weight on the bit are next in importance, although the weight on the bit is one item in the study that has not yet come within the scope of rigid analysis. According to the records studied, it is estimated that for each 33 percent increase in rotating speed an increase of 108 percent in the rate of penetration results, and for each 200 gallons per minute increase in volume of mud fluid circulated there is an increase in rate of penetration of 28 percent.

Investigation of the maximum rotating speed and weight on the bit indicates that these factors are limited by the strength of the bit and the drill pipe. The amount of mud fluid circulated is governed by the type of formation being drilled.

An interesting observation is the part played by the drilling crew. It was found that the efficiency of the drilling crew accounted for as high as 55.5 percent of the total increase in rate of penetration.

Positive data of this type are invaluable in deep-well drilling, for drilling costs mount rapidly with depth. In many instances the increase is so great that companies are forced to extreme measures in an effort to reduce drilling costs.

Studies of this kind on rate of penetration have been all too few. The positive results obtained and their immediate practical value in effecting substantial drilling economies warrant further intensive investigation of this little-known but vital phase of drilling operations.

Monopoly Hearings Scheduled

Public hearings on the oil industry are scheduled to begin in Washington early next month before the Temporary National Economic Committee, known also as the Anti-Monopoly Investigating Committee. A thoroughly impartial inquiry will be made into the problems of each branch of the industry, the avowed purpose being to obtain a faithful record of the way the industry is being conducted.

As if to allay any undue concern leaders in the industry may have regarding the projected plans of the Committee, each branch of the industry will be invited to select witnesses. Witnesses will be invited to present such evidence as will constitute an adequate presentation of all available information with respect to the manner in which the industry is conducted.

Questionnaires containing thirty-five main questions have been sent to forty oil companies. The information requested is amazing in its comprehensiveness, and will probably be used as a basis for conducting the hearings. Preparation of this information will be a formidable task for many of the companies. It must be in the Committee's hand by May 22nd. A thoroughly detailed picture of the workings of the industry is desired. It will involve delving into company records, a task that will occupy the time of a large group of competent workers.

What good the industry will derive from this inquiry is at present conjectural. Will the expenditures made in preparing information and the costs incurred in presenting testimony be justified?

Many of the industry's problems in recent years have been grossly magnified because of the wide publicity given to the grievances of small factions within the industry itself. It is to be hoped that the public hearings about to begin will be kept free of factional and personal grievances and that witnesses presenting evidence will do so with the general welfare of the petroleum industry at heart.

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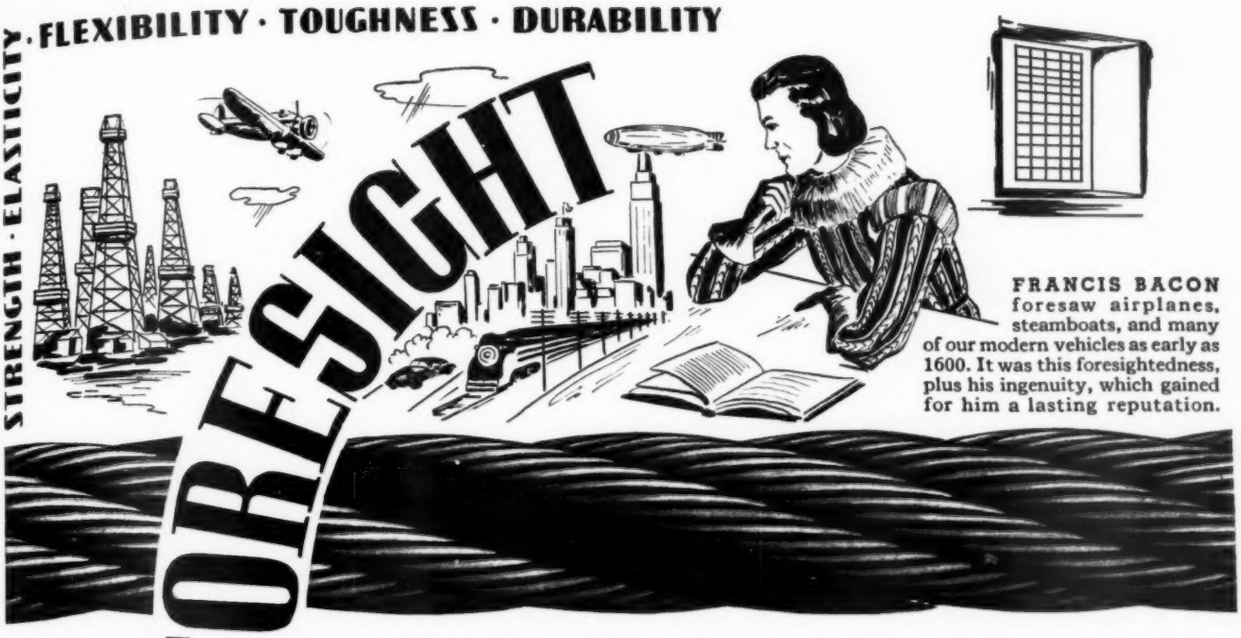

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« « HIGHLIGHTS IN OILDOM » »

Texas Oil Proration Laws Extended

Texas' oil proration laws will continue in effect until September 1, 1941, under the provisions of a bill that has passed both branches of the legislature. No changes were made in the existing laws. The Railroad Commission will continue to determine allowables of the various fields as in the past.

A last-minute effort to delay passage of the bill until the question of imports could be studied was defeated. The motion for delay was made by A. M. Aikin, Jr., of Paris, who said that last February more than 9,000,000 bbl. of oil were imported into Texas and only 16,000,000 bbl. exported. His thought was that proration is entirely too restrictive when it causes such a situation. His motion to postpone consideration of the bill, however, was overruled.

●

Crude Price Changes in Louisiana and Michigan

On April 23 the Atlas Pipeline Company and the Caddo Pipe Line Company announced a price advance of 4 cents a bbl. for Cross Lake crude oil, North Louisiana, bringing their price to $1.05, which has been the posted price of large buyers in the area. The action was made effective as of April 18.

On April 30 the Caddo Crude Oil Purchasing Company announced a 10 cents per bbl. reduction in prices posted for crude oil in the Lisbon field of 35-gravity and above. The reduction was to 77 cents a bbl.

Prices for crude oil from the Freeman and Sherman pools, Michigan, was advanced the latter part of April by 7 cents a bbl. to 89 cents, and prices in the Buckeye, Bentley, Edenville, and Beaverton pools were advanced 5 cents a bbl. to 95 cents. Prices for crude oil from the Greendale, Porter, and Crystal pools were advanced 5 cents a bbl. to 97½ cents.

●

U. S. Shipments of Petroleum Products to Italy Increased

Shipments of petroleum products from the United States to Italy showed a marked increase in 1938, a report from the American consulate-general, Genoa, to the U. S. Department of Commerce reveals. The United States and Rumania are the principal suppliers of petroleum products to the Italian market, the report points out.

Imports from the United States comprised 37 percent of Italy's petroleum receipts in 1938 compared with 13½ percent in 1936. On the other hand, imports of Rumanian petroleum showed a marked decrease, declining from 39 percent in 1936 to 20 percent in 1938.

Other sources of Italy's petroleum imports in 1938 were: Iraq, 9 percent; Iran, 5.38 percent; Colombia, 4.48 percent, and Albania, 2.49 percent.

Total shipments of petroleum and petroleum products from the United States to Italy in 1938 were 2,642,760 metric tons (18,499,320 bbl.) as against 2,606,320 metric tons (18,244,240 bbl.) in 1937.

Conservation and Proration Subject of Meetings

The series of meetings held by a special committee of the Illinois Legislature relative to the desire for a conservation law and proration of production in the state has been completed. Testimony has been taken at meetings held at Salem, Champaign, Centralia, and Mattoon.

Oil producers, with but few exceptions, have gone on record as favoring such a law. Objections have been principally from small local refineries or from those who wish to erect plants close to the source of crude oil supply.

Ora P. Tuttle, chairman of the committee, after the final hearing at Mattoon, stated his committee would begin consideration of the testimony at once and subsequently would make its recommendation to the state legislature.

●

Next Houston Oil Show Will Be Held in 1942

The Oil-World Exposition, Inc., has voted to hold its next show in 1942 and thereafter every four years. This action was taken by the membership after messages were received from executives of many large oil companies in which they expressed themselves as favoring less frequent oil shows. The messages were sent in reply to an invitation by John R. Suman, president of the Oil-World Exposition, Inc., for an expression of opinion.

The next show at Houston will be two years after the 1940 show of the International Petroleum Exposition in Tulsa, Oklahoma, and, in the meantime, that organization will be asked to adopt a similar schedule so that only one oil show will be held every two years.

●

Michigan Bills Pass Both Houses of Legislature

Two bills, one to regulate the production of oil and the other to regulate the production of gas in Michigan, have passed both houses of the state legislature.

Under the provisions of the bills control of oil and gas drilling and production is placed in the hands of the state supervisor of wells. He also is a director of the state department of conservation. An advisory board consisting of six members of the industry shall be associated with the supervisor. The latter shall have power to dictate the spacing of wells and to prorate production for the state as a whole or for individual fields.

●

New Texas Gas Bill Passes Senate

A new gas proration bill, providing for the fixing of gas allowables in the Panhandle field, Texas, based upon prevention of drainage, has been passed by the Texas Senate and sent to the House.

An amendment was made to the bill before passage, which, if eventually made into law, will be a distinct deterrent to gas recycling operations. It provides that any gas well producing a liquid petroleum shall be prorated to the same amount of fluid that oil wells are allowed to produce.

Although the original bill applies only to the Panhandle area, the amendment contains a section that would be statewide in effect. Numerous protests have been made to the amendment by gas recycling interests.

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Major Pipe Line Activities

CONTRACTS have been let for the laying of Socony-Vacuum Oil Company's 355-mile, 10-in. line from East St. Louis, Illinois, to Lima, Ohio. The construction work will be done by three contractors, T. R. Jones, Inc., who will lay the east 112 miles of the line, O. C. Whitaker Company, who was awarded the central section of 112 miles, and Sheehan Brothers Construction Company, who was given the west 131 miles.

Work is to begin at once on all sections, the line to be completed by August 1.

The line will be constructed under the supervision of the Magnolia Pipe Line Company, subsidiary of Socony-Vacuum.

The western terminal of the line will be at the Mitchell Station, near the East St. Louis refinery of Socony-Vacuum Oil Company. From the Patoka Station in Illinois a 11-mile, 10-in. line will be laid southward to Sandoval where it will tie-in with the gathering system of the Magnolia Petroleum Company that serves the Salem-Lake Centralia area. Other laterals also will be laid in the Illinois Basin area.

The new line is being laid primarily to supply crude oil to Socony-Vacuum's refineries at Trenton, Michigan, and Buffalo, New York. Its capacity will be 40,000 bbl. per day.

●

Shell Pipe Line Company officials have announced that a 6-in. pipe line will be laid to connect the Wasson field of Yoakum and Gaines counties, Texas, with the company's trunk system at Hobbs, New Mexico. The length of the line will be 30 miles and its capacity 12,000 bbl.

Aloco Pipe Line Company is now laying a line from the Wasson field to Hobbs where it will connect with the Atlantic Pipe Line Company's trunk system.

The Humble Pipe Line Company is operating its 6-in. line from Wasson field to Hobbs at capacity, which is 12,000 bbl. per day. The company is making no new connections, however, as present connections are prorated to 78 percent of allowable.

●

Panhandle Refining Company has made preliminary plans to lay a gathering line from the company's refinery at Wichita Falls, Texas, to the west side of the K.M.A. field. The right-of-way already has been surveyed.

The line will be a 4-in., 26 miles in length. The Panhandle wells that will be connected to the line are on the Griffin and J. S. Stone properties.

●

Jenkins Oil Corporation of Dallas, Texas, has sold to the Sinclair Refining Company the Control Gathering System in the East Texas field. The sale was announced following a hearing at Kilgore, Texas, before the State Tender Board, at which approval of overage oil was sought. Approval was granted on written authority of John E. Taylor, chief deputy supervisor of the commission, it is stated. The overage involved 2665 bbl. of oil accumulated between August 1, 1936, and April 1, 1939. Wallace Jenkins explained that the overage was accumulated during that period in which the system transported 1,561,354 bbl. Sinclair is to purchase the overage at the posted price.

The Control Gathering System is connected to 93 wells.

●

The Monarch Construction Company, Pampa, Texas, was awarded the contract to lay the 6-in. line of the Sinclair Refining Company, Pipe Line Department, from the K.M.A. field, Wichita County, Texas, to the company's Hensley station six miles southwest of Jacksboro in Jack County. The length of the line will be 65 miles.

Construction is being rushed and it is planned to have the line completed this month.

Completion of the line will relieve an undesirable situation in the field. For some time pipe-line outlets have been insufficient. Sinclair will take over all leases in the northwest part of the field that it turned over to The Texas Pipe Line Company on March 1, comprising 34 wells on 16 leases and having a total daily output of 1035 bbl. Sinclair also will acquire from The Texas Pipe Line Company connections on virtually all leases west of Kadane Corner. The latter company, thus relieved, will now be able to take full allowable from its connections. Sinclair may also take enough connections from the Continental Pipe Line Company to permit that firm to take the full allowable from its connections. These changes are expected to end pipe-line proration in the area.

●

A 30-mile gas pipe line connecting the field in Lincoln, Freeman, and Redding townships with the Austin Township field of Mecosta County has been announced by the American-Michigan Pipe Line Company, affiliated with the Michigan Consolidated Gas Company. The project has the approval of the Public Utilities Commission.

A gathering system will be constructed in Clare County, in which Lincoln, Freeman, and Redding are situated, and a 4-in. line laid from there to Mecosta County. Construction of the line is not scheduled to begin until about August 1, it is announced by Dean W. Flowers, Muskegon manager of Michigan Consolidated Gas Company and vice-president of the American-Michigan Pipe Line Company.

●

The Tri-Lakes Pipe Line Company, a subsidiary of the Simrall Pipe Line Company, has completed a gathering system in the Bangor pool, Van Buren County, Michigan. Shipments are made from the field by rail and truck. The company has also made a six-car addition to its loading rack at Bloomingdale.

●

Root Petroleum Company has purchased from the Standard Oil Company of Louisiana its gathering system in the East El Dorado field, Arkansas. The system is connected to 55 leases from which the daily production is 825 bbl. of crude oil.

●

The Osage Construction Company of Great Bend, Kansas, has laid 19 miles of 2-in. and 4-in. pipe line in the Nowata, Oklahoma, area for the Stanolind Pipe Line Company to connect wells taken over by the latter from the National Refining Company.

●

The Lone Star Gas Company proposes to lay a 17-mile line from San Angelo, Texas, to Sanatorium, Texas, and Carlsbad, New Mexico. The line will be constructed mostly of 6-in. pipe, although a short section of 8-in. is to be laid. Gas supply is from the Big Lake field and fields in Coleman County.

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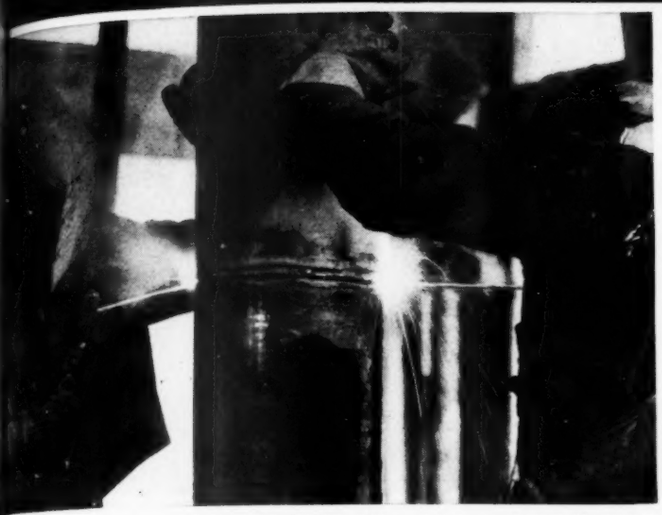

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Activities in the Oil Fields

NO. 1 W. K. Hoffman of the Parr Drilling Company, Springfield prospect, Jim Wells County, Texas, apparently has opened a new field and at the same time given the county its first Yegua production. Casing was set at a depth of approximately 5800 ft. for a production test after an electrical survey showed oil sand at 5630-38 ft. Sidewall cores at that depth recovered saturated oil sand.

o

Midwest Development Company No. 1 Wirth, a wildcat east of Princeton, Indiana, flowed 23 bbl. of crude oil an hour through tubing. The St. Genevieve formation was penetrated at a depth of 1601 ft. and the McCloskey at a depth of 1609 ft. When the test had reached a depth of 1619 ft. the hole filled 1000 ft. with oil in 12 hours. It was drilled on to 1621 ft. and acidized with 500 gal.

o

No. 1 McWhorter of Kingwood Oil Company et al, a wildcat near Effingham, Effingham County, Illinois, is drilling below 6000 ft. This is the deepest test yet to be drilled in the Central Coal Basin, and has as its goal the St. Peter zone.

o

Extended production in the West Little River pool, Oklahoma, a half mile eastward, Atlantic Refining Company and Midstates Oil Corporation have brought in their No. 1 Jimmie, in SE NW NE of 21-7-6e. The well swabbed 521 bbl. of oil in a 16-hr. test and was shut down for pumping equipment to be installed.

o

Magnolia Petroleum Company No.1 Roseberry, in 29-23n-9w, Webster Parish, Louisiana, drilled to a total depth of 9250 ft., swabbed and flowed 83 bbl. of crude oil in 24 hours. This is the first oil well to produce from the lower Marine zone in the Shongaloo field. Other wells in the field that produce from that zone are distillate wells.

Phillips Petroleum Company No. 1 R. Proffitt, in CE½ NE NE of 8-20-9w, producing 177 bbl. of oil per day from Arbuckle dolomite at a total depth of 3259 ft., has opened a new pool in Rice County, Kansas.

o

No. 1 White of R. Olsen et al., in CNE NE of 30-11-1e, near Newalla, Oklahoma, southeastern Oklahoma County, flowed 18 bbl. of oil per hour through 2½-in. tubing. Production is from the Hunton lime at a total depth of 6000 ft. This well opens a new pool.

o

The finding of production in the Ellenberger lime in Pecos County, Texas, which would open the third Ordovician field in the West Texas Basin, is in prospect. Two drill stem tests were made of Anderson-Prichard and Monte Warner's No. 1 M. I. Masterson, drilled to a total depth of 4595 ft. The second test, for 38 minutes, recovered 180 ft. of 42-gravity oil and 240 ft. of mud cut 85 percent with oil.

o

The only Glenrose field for Arkansas other than the Miller County extension of Rodessa apparently was opened in La Fayette County, near Stamps, when Erwin E. Leach and the East Texas Refining Company completed their No. 1 G. E. Patten Estate. Production is from the Hill zone and initial flow was 100 bbl. through a 1-in. choke. The well was plugged-back to 3481 ft. from a total depth of 3604 ft.

o

O.K. Supply Company No. 1 Knabe, in C NE NW of 15-14-22e, discovers a Bartlesville sand pool in Johnson County, Kansas, on the flank of the Forest City Basin area. The well was drilled to a total depth of 856 ft. and is estimated for a production of about 75 bbl. of oil per day.

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Kansas	.60-1.10	Buckeye	1.55
Oklahoma	.60-1.10	Corning	1.02
Arkansas	.73	Canada	2.10-2.17

DAILY AVERAGE CRUDE OIL PRODUCTION

Data Supplied by A.P.I.

(Figures in Barrels)

	[1]B. of M. Calculated Requirements (April)	Week Ended April 22, 1939	Week Ended April 1, 1939	Week Ended April 23, 1938
Oklahoma	473,300	451,600	422,200	499,400
Kansas	152,700	171,000	167,000	181,900
Panhandle Texas		74,100	64,150	62,100
North Texas		84,450	84,300	77,100
West Central Texas		31,300	31,000	29,650
West Texas		229,650	211,650	196,150
East Central Texas		104,750	93,950	100,700
East Texas		446,650	372,700	432,400
Southwest Texas		236,650	251,400	232,500
Coastal Texas		226,600	219,300	208,950
TOTAL TEXAS	1,412,700	1,454,150	1,334,450	1,339,550
North Louisiana		75,300	69,200	80,000
Coastal Louisiana		193,500	191,200	182,500
TOTAL LA.	262,000	268,800	260,400	262,500
Arkansas	53,300	52,650	54,250	53,700
Illinois	149,200	174,500	169,300	(
Eastern (Not incl. Illinois)	104,800	98,750	99,250	(149,550
Michigan	48,300	61,100	58,100	51,050
Wyoming	50,000	57,540	56,150	50,100
Montana	15,300	14,350	13,250	13,100
Colorado	5,000	3,550	3,750	4,400
New Mexico	115,300	108,100	108,600	105,950
TOTAL EAST OF CALIF.	2,842,000	2,916,000	2,746,700	2,711,200
California	592,000	610,700	611,500	728,900
TOTAL U. S.	3,434,000	3,526,700	3,358,200	3,440,100

[1]These are U. S. Bureau of Mines' calculations of the requirements of domestic crude oil based upon certain premises outlined in its detailed forecast for the month of April. As requirements may be supplied either from stocks, or from new production, contemplated withdrawals from crude oil inventories must be deducted from the Bureau's estimated requirements to determine the amount of new crude to be produced.

Great Pioneers

OKLAHOMA 1889

Following the acquisition from the Indians of the territory now part of Oklahoma, President Benjamin Harrison announced this land would be opened to homestead. 20,000 hardy pioneers were at the border on April 22nd, 1889. At 12 o'clock noon, the signal was given. There ensued the most spectacular race for homes ever seen. The enterprise of these brave men has been rewarded many fold. Oklahoma is today one of the world's greatest oil-producing regions.

● IN ANY FIELD the venturesome spirit of the pioneer spells leadership. It was said, for instance, that the chemical treatment of oil and gas wells could never be practical. But Dowell in 1932 perfected and announced *Inhibited* Acidizing, one of the most important contributions ever made to oil production.

Operators using Dowell Service have recovered millions of *extra* barrels of oil—restored profitable production to thousands of stripper wells.

Important Dowell contributions include Dowell "XX" Intensified Acid, Dowell "XR" Sustained Action Acid, Jelflake Seal and many others—each designed to solve specific problems of the industry. Dowell's vast research facilities will continue to pioneer further developments of oil and gas well chemical service. Operators who "Look to Dowell" will be justly rewarded through greater production—lower costs.

DOWELL INCORPORATED

General Office: KENNEDY BUILDING, TULSA, OKLA.

Subsidiary of THE DOW CHEMICAL COMPANY

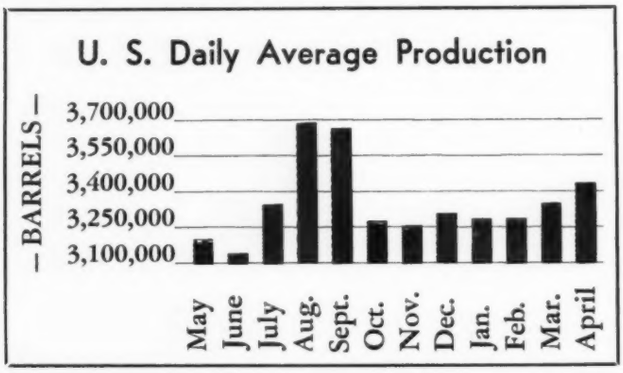
Oil men who attend the Golden Gate International Exposition are cordially invited to visit the Dowell exhibit in The Dow Chemical Company booth.

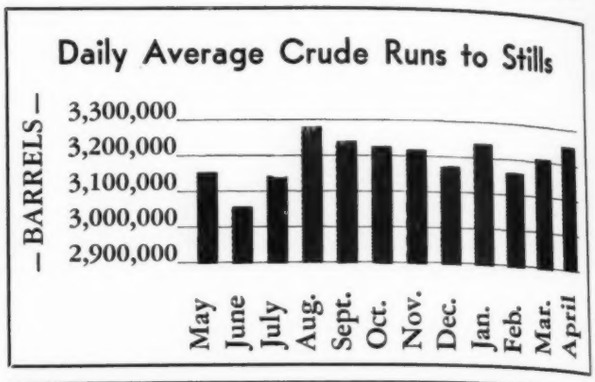
Look to

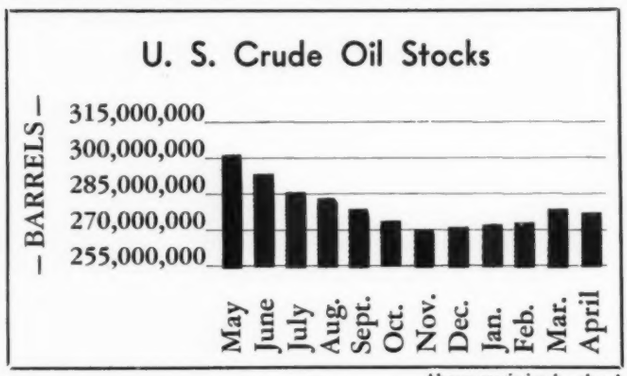
DOWELL

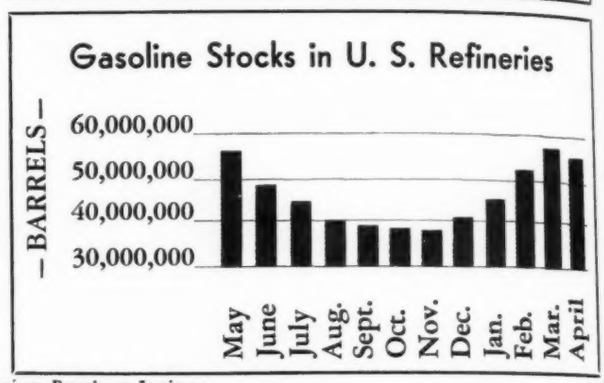
OIL AND GAS WELL CHEMICAL SERVICE

Petroleum Statistics and Field Activities









Above statistics by the American Petroleum Institute.

Summarized Operations in Active Fields for April, 1939

Fields	Completions	Producers	Rigs	Drilling Wells	Depth of Production	No. Casing Strings	Gravity of Oil	Type of Tool Used
TEXAS								
East Texas	10	10	8	23	3500-3700	2	40	Rotary
Duval County	35	26	4	11	1554-2900	2	22	Rotary
Ector County	35	34	4	53	3675-4377	2 and 3	32-36	Rot.-Cab.
Panhandle	27	24	25	70	1700-3900	2	40	Rotary
Refugio County	16	16	2	5	4900-5900	2	38	Rotary
Nueces County	16	13	2	5	3922-5878	2 or 3	21-54	Rotary
Winkler County	14	14	2	12	2850-3450	2 and 3	30-38	Rot.-Cab.
K. M. A. Field	25	25	24	42	3730-3935	2	42-43	Rot.-Cab.
OKLAHOMA								
Oklahoma City	3	3	1	3	6450-6682	3	39	Rotary
Fitts Pool	15	12	2	14	1800-4488	2 or 3	38	Rotary
KANSAS								
Russell County	12	8	4	20	2926-3435	2 and 5	32-37	Rot.-Cab.
Rice County	12	10	5	22	3222-4085	2 and 5	42-48	Rot.-Cab.
Barton County	17	10	5	20	3290-3518	2	39-42	Rot.-Cab.
ILLINOIS								
Central Illinois	283	210	43	323	1425-4100	2	36-38	Rot.-Cab.
NEW MEXICO								
Lea County	34	33	4	68	3150-4030	3	30-34	Rot.-Cab.
CALIFORNIA								
Kettleman Hills	2	2	3	11	8300-8730	3 or 4	40	Rotary
Wilmington	21	21	7	9	3500-4000	2 and 3	18-20	Rotary

Field Activities by States for April, 1939

State	Completions		Producers		Locations		Rigs		Drilling Wells		Production, 1938 (In Barrels)
	April	March	April	March	April	March	April	March	April	March	
Arkansas	12	17	10	13	15	19	14	16	22	24	18,211,617
California	93	73	77	55	98	39	77	72	180	163	249,918,001
Colorado	3	1	1	1	....	....	2	2	25	28	1,371,687
Illinois	273	282	201	205	30	31	261	266†	75	77	23,306,000
Indiana	11	6	6	1	....	10	1	2	45	43	965,900
Kansas	90	74	65	55	98	123	30	36	141	146	58,795,545
Kentucky	51	43	21	26	....	....	7	4	103	98	5,828,650
Louisiana	73	69	53	41	59	91	49	57	146	149	94,941,537
Michigan	101	86	58	58	92	112	34	39	156	157	19,140,966
Mississippi	0	0	0	0	....	....	4	8	3	2	Gas Prod.
Montana	13	6	10	3	....	....	5	7	52	56	4,858,458
New Mexico	42	42	34	36	....	....	20	15	120	129	39,902,263
New York	38*	31*	37*	31*	....	....	4	4	6	5	5,040,600
Ohio	49	56	36	44	....	....	35	27	130	92	3,292,100
Oklahoma	158*	149*	110*	103	162	191	34	39	256	262	171,312,098
Pennsylvania	112*	84*	107*	76*	....	....	....	....	....	....	17,431,500
Texas	722	681	521	509	805	1149	245	268	884	896	473,304,662
West Virginia	32	46	27	38	....	....	18	10	73	75	3,700,375
Wyoming	4	8	3	4	....	....	7	8	65	63	19,005,638
Total	1877	1754	1377	1299	1359	1765	847	880	2482	2465	1,206,827,597

*Includes water-intake and pressure wells.
†Includes 208 rigs standing and 58 rigging up.

Activities in Refining

Percent Refining Capacity Operated

Western Division, 60.1 Percent **Central Division, 81.9 Percent** **Eastern Division, 85.7 Percent**

TWO companies are reported to be planning the installation of refineries in Wisconsin. One plant would be situated near Madison and the other near Milwaukee. The companies contemplating the projects are the Wisconsin Oil and Refining Company and the Fiore Coal and Oil Company.

Phillips Petroleum Company recently purchased from The Cooper-Bessemer Corporation two of that manufacturer's Type 24 heavy horizontal gas engines. These units, having 24-in. bore and 36-in. stroke, are destined for installation in the Phillips' Borger, Texas, refinery, and will drive Union Steam Pump Company's quintuplex pumps. The engines are rated from 650 hp. at 125 r.p.m. to 730 hp. at 138 r.p.m., and both will be suitable for compressor cylinder drive should the operator desire to use them for that purpose at a future time. Fast flexible couplings will connect the Cooper-Bessemer units to their separate pumps.

Tide Water-Associated Oil Company and Seaboard Oil Company have awarded to J. F. Pritchard and Company the contract for construction of the high-pressure refrigeration, extraction, and recycling plant in the Long Lake field, Anderson County, Texas, announced recently. The plant, when completed, will have a capacity of 25,000,000 cu. ft. of gas per day, and will produce 25,000 gal. of gasoline per day. It is expected to be completed about July 15.

The Ray Hose interests, Springfield, Illinois, recently acquired the Gladewater, Texas, plant of the Solvex Refineries, Inc. The plant will be dismantled and the equipment moved to a site between Springfield and Decatur, Illinois, where it will be reassembled. A Dubbs cracking unit will be added. Crude supply will be from the new Illinois fields.

Atlantic Refining Company is one of the latest firms to announce plans for construction of a natural gas recycling plant. The plant will be situated in the Weslaco, Texas, gas-distillate field south of the town of Weslaco.

The discovery well in the Weslaco field was completed in February, 1938. Drilled to a total depth of 9180 ft., the well was completed by gun-perforation at a depth of 8634-42 ft. Officials of the Atlantic Refining Company state at least five deep wells will be completed before the plant is placed in operation.

Champlin and Bass and James A. Patton of Dallas, Texas, have completed erection of their gas recycling plant in the Long Lake field, Texas. The site of the plant is on the John W. Focke lease in the northern part of the field.

A combination skimming plant and absorption-type natural gasoline plant is being erected 4 miles east of Graham, Texas, by the Cosden Petroleum Corporation. The plant will have a capacity of 2500 bbl. of crude oil per day and 5,000,000 cu. ft. of gas. The Sewell block, upon which the plant is situated, comprises 3375 acres. The Cosden company has two gas wells and four oil wells on the tract and a fifth oil well is nearing completion.

The Southport Petroleum Company, Kilgore, Texas, is planning the construction of a refinery at Henderson, Kentucky, it has been announced. The plant will have a capacity of 3000 bbl. per day.

The Falcon Refining Company is remodeling and enlarging its Great Bend, Kansas, refinery to increase its capacity to 4000 bbl. per day. A new bubble tower and Dubbs cracking unit will be added to the existing equipment.

Gas and Oil Products, Inc., is adding a cracking unit to its refinery in the South Turner Valley field, Canada, which will be completed and in operation by July 15. As a part of its enlargement program an Ethyl blending plant also is being erected.

Mid States Refining Company has purchased the Henry H. Cross refinery at Joliet, Illinois. Crude supply is from Illinois fields and the finished gasoline is being marketed in the Chicago area. R. D. Swan, president of the Mid States Refining Company, formerly was with The Texas Company.

Crude Runs to Stills, Gasoline, Gas and Fuel Oil Stocks
Week Ending April 22, 1939

A.P.I. Figures

(Figures in thousands of barrels of 42 gal. each)

DISTRICT	Percent Potential Capacity Reporting	Daily Average Crude Runs to Stills	Percent Operated of Total Capacity Reporting	Total Motor Fuel Stocks	Total Gas and Fuel Oil Stocks
East Coast	100.0	516	83.9	22,297	5,459
Appalachian	85.9	108	84.4	3,565	732
Ind., Ill., Ky.	89.5	456	88.7	15,115	4,569
Okla., Kans., Mo.	81.6	277	81.0	7,697	3,859
Inland Texas	50.3	122	76.7	1,636	1,726
Texas Gulf	89.5	774	86.5	11,099	7,623
La. Gulf	97.3	132	91.0	2,928	1,720
No. La. & Ark.	55.0	41	74.5	475	731
Rocky Mt.	54.2	36	56.3	1,771	724
California	90.0	477	64.0	15 956	96,900
Reported	85.8	2,939	80.3	82,539	124,043
Estimated Unreported		341		5,230	2,850
*EST'D TOTAL U. S. APR. 22, '39		3,280		87,769	126,893
*EST'D TOTAL U. S. APR. 15, '39		3,330		87,071	126,798
U. S. B. of M *APR. 22, '38		**3,189		90,662	126,184

*Estimated Bureau of Mines' basis.
**April, 1938, daily average.

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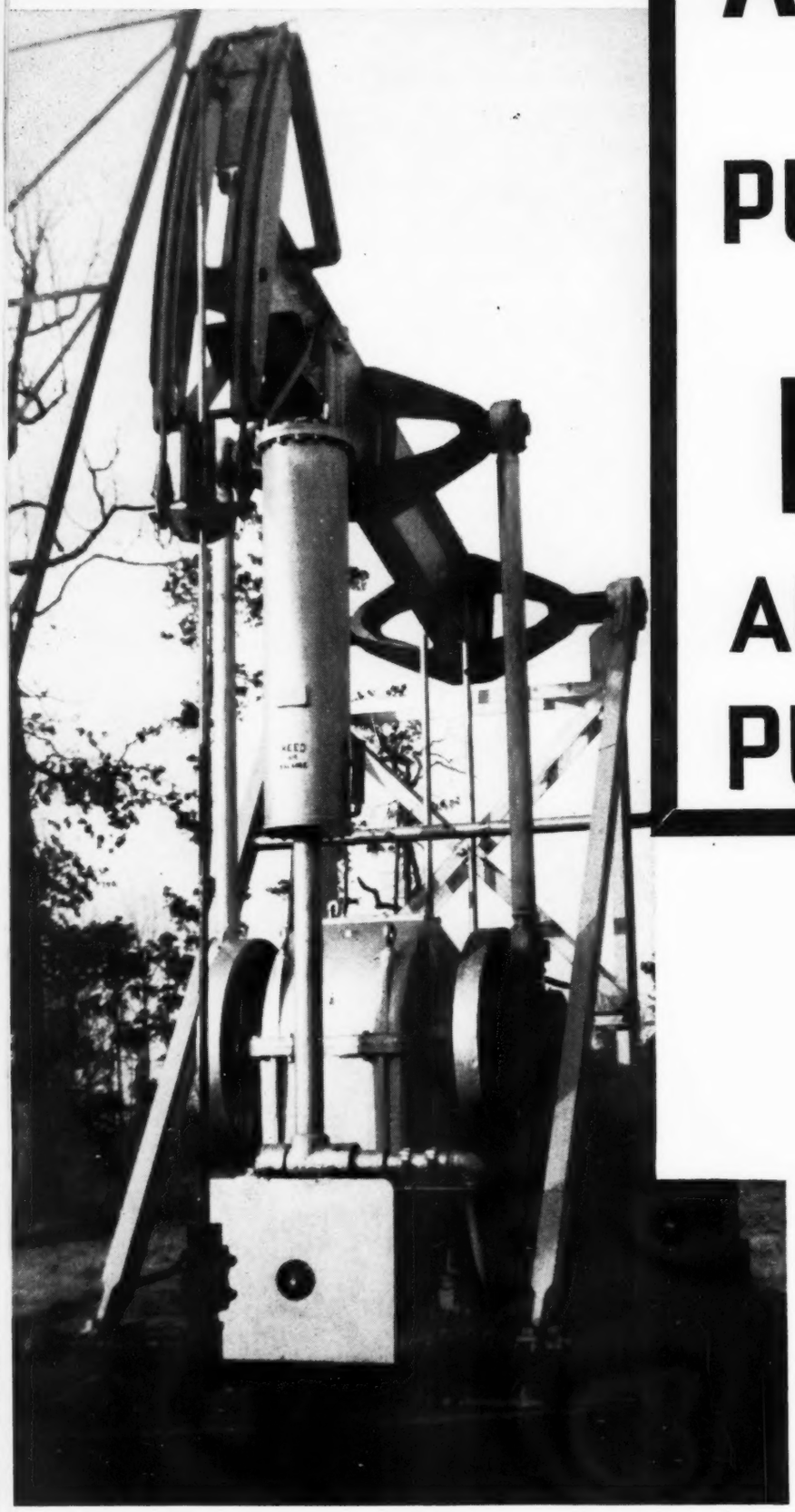
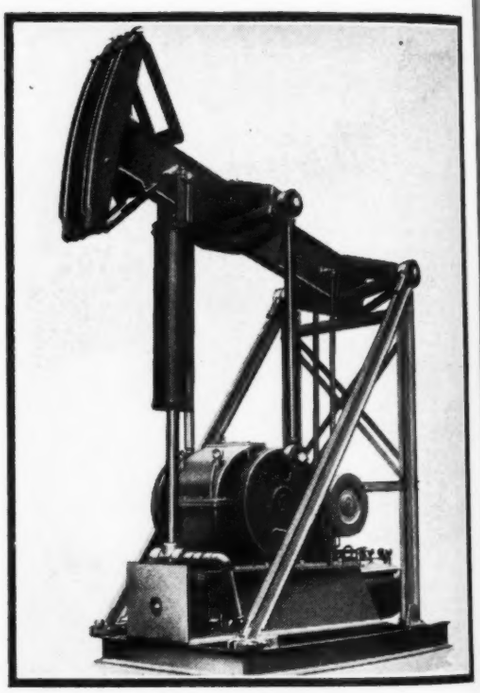




The air system of balancing provides a cushioning effect which eliminates vibration at high and low speeds, reducing the liability of rod failures, providing efficient pump action and increasing rod life. The elimination of heavy oscillating or rotating counter-weights permits a very compact unit construction, allowing installation diagonally on the derrick floor, if desired. HEAVY AND COSTLY FOUNDATIONS ARE NOT NEEDED TO HOLD THE UNIT DOWN.

REED ROLLER BIT COMPANY

P 420.4
P 940.1

THE Petroleum Engineer

MAY, 1939

A PETROLEUM ENGINEER FEATURE

An Economic Study of Slim-Hole Drilling in the Gulf Coast

Breakdown and analysis of costs derived from factual data indicate the feasibility of exploratory slim-hole drilling for testing deep Gulf Coast structures

By
I. W. ALCORN

Chief Petroleum Engineer,
Gulf Coast Producing Division, Pure Oil Company

FOR many years core test holes for exploratory work have been drilled successfully, the principal object of which is to determine regional structure by drilling only to a geologic marker. Recently these small-diameter holes have been drilled to test producing levels, particularly in the shallow areas of the Mid-Continent, where, in general, depths of 4000 ft. were not exceeded. Although the results of this work were well known, not much thought was given to the possibilities of such wells in the Gulf Coast, where holes are drilled to extreme depths in formations composed of shale and sand, and where there is the possibility of encountering heaving shale, excessive gas pressure, and flow of salt water.

Method of Analysis

A careful study and analysis of past drilling records led to the conclusion that core tests, or "slim holes" as they are termed here, could be drilled successfully to the depths usually drilled on the Gulf Coast, and at a much smaller cost than that of the ordinary well. Of primary importance in a study of this kind is the arrangement of records so that they can be easily summarized and pertinent facts readily deduced. It is desirable to derive three distinct sets of data. The first is a regular time-depth drilling curve, which includes a complete breakdown of time, bit records, and other data, such as curves of rotary r.p.m., weight on bit, and pump pressure, as indi-

I. W. ALCORN

was born September 5, 1899, at Marietta, Ohio—Has received degrees in mining engineering from the Missouri School of Mines, Rolla, Missouri, and Massachusetts Institute of Technology—Began career in oil industry with Independent Oil and Gas Company—Later served on staffs of Smith Separator Company and Oil Well Supply Company—Employed by Pure Oil Company in November, 1935—Elected first president Houston Technical Club, organized in 1938.

cated in Figs. 1 and 2. The second is a breakdown of operations summarizing the facts concerning the individual wells, such as time required and other pertinent information, as shown in Fig. 3, and supplemented by a summary of cost of vital operations, as indicated in Figs. 4 and 5. The third set of data consists of composite time-depth curves for certain classifications of wells, depending upon the items to be compared. With these factual data as a basis, almost any operation connected with the drilling of a well can be readily analyzed with respect to both time and cost, at least the relative cost, and so the time and cost of the operation in other wells predicted.

A study of such analyses comparing data on the drilling of extra-large holes (18⅝-in. surface casing) with similar data covering the drilling of normal holes (10¾-in. surface casing) led to predictions concerning the drilling of the slim holes (7⅝-in. or 8⅝-in. surface casing). In actual practice predictions made on the basis just described have proved remarkably correct in all respects. After all, the drilling of a well is a job of excavation involving the moving of so many cubic feet of earth, limited, of course, by certain mechanical operations and equipment. Disagreement on these items, and a fear concerning the hazard of drilling, sometimes govern the decision on whether to drill large holes. All the data, mechanical considerations, and costs as derived from factual information presented here indicate that drilling holes of small diameter in the instances cited was sound practice, the economy of which is a big factor in its favor.

Modern Equipment and Materials

The drilling of exploratory wells in an endeavor to increase known reserves of oil represents an increasingly large cost. This cost the industry must absorb in its overall economic picture, and it would seem that effort and money have been applied to improving the mechanical technique of deep drilling, but not enough attention paid to the task of developing a proper cost analysis of such work. Adherence to the practice of drilling large exploratory holes is inherited from cable-tool drilling practice. In cable-tool drilling a large hole is almost a practical necessity, but its necessity should be questioned before drilling with rotary tools. The basis for this statement is that reaming cost, mud cost, and fishing cost are each a function of trouble. It has been noted that these items are reduced almost to the minimum in slim holes and tend to increase with the size of the hole drilled. Stating this another way: one of the paradoxes of rotary drilling is that when a deep exploratory hole is projected, the idea is generally advanced that a program should be adopted wherein a large string of surface pipe is set at greater than normal depth, the hole is then reduced and another string of casing set, the idea being that if trouble develops, pipe can be run and there will still be room enough to work; overlooked entirely is the probability that running a protective string of casing is a contingent measure

Fig. 1. Forms used to record: (a) bit changes; (b) summary of drillers' performance; (c) mud materials; (d) deviation, and (e) analyses of labor

BIT RECORD

				Drilling				Coring				Reaming		Totals				
No.	Make	Type	Size	From	To	Hrs.	Ft.	From	To	Hrs.	Ft.	Hrs.	Ft.	Hrs.	Ft.	Condition of bit	Cost	Cost per ft.
1																		
2																		
3																		

DRILLERS RECORD

Name of driller	Ft. drld.	Hours	Ft. per Hr.

BREAKDOWN OF OPERATIONS TIME

Operation	Hours	% Total Hours
Drilling		
Coring		
Reaming		
Round trips - changing bits		
Repairing rig		
Repairing engine		
Repairing pump		
Running cement & casing		
Waiting on cement		
Fishing		
Syfo		
Mixing mud		
Circulating		
Changing - repr'g. D.P.		
Schlumberger		
Waiting on material		
Stringing block		
Miscellaneous		
Perf. - D.S.T.		
Rigging-up to spud		
Completing		
Total		100.00

MUD RECORD

Quantity	Name of material	Unit cost	Total cost

MAN HOURS

Operation	
Rigging-up	
Erecting derrick	
Moving material	
Drive piling and build structure	
Total	

DEVIATION RECORD

Depth	Amt. of Dev.

adopted because of drilling the large hole.

Developments in equipment and methods in recent years can be used to great advantage in reducing costs of drilling and completing wells, and reducing the hazards. Among these is the development of internal-flush drill pipe, which lends itself admirably to slim-hole drilling by creating a better balance between friction inside the pipe and velocity of the mud stream in the annular space. This becomes particularly important at depths exceeding 7000 ft. More recently, following the marketing of Grade D-80 casing, experimental strings of 3½-in. internal-flush drill pipe are being manufactured of the same steel, permitting equivalent strength at a weight reduction of 30 percent.

Electrical logging devices have been developed that tend to reduce the amount of coring necessary.

Side-wall sampling can be used to advantage if a formation has not been cored or if cores were unrecovered.

Development of gun-perforating has brought about changes in completion programs. Cementing practices and the use of tools such as the cement retainer have been greatly improved.

Constant improvement has been made in multi-speed drawworks and in the application of Diesel-mechanical drives. Although the straight mechanical drive has some undesirable features, owing to the limitations of friction clutches, these clutches are gradually being improved and in the offing is the possibility of using hydraulic couplings and magnetic clutches.

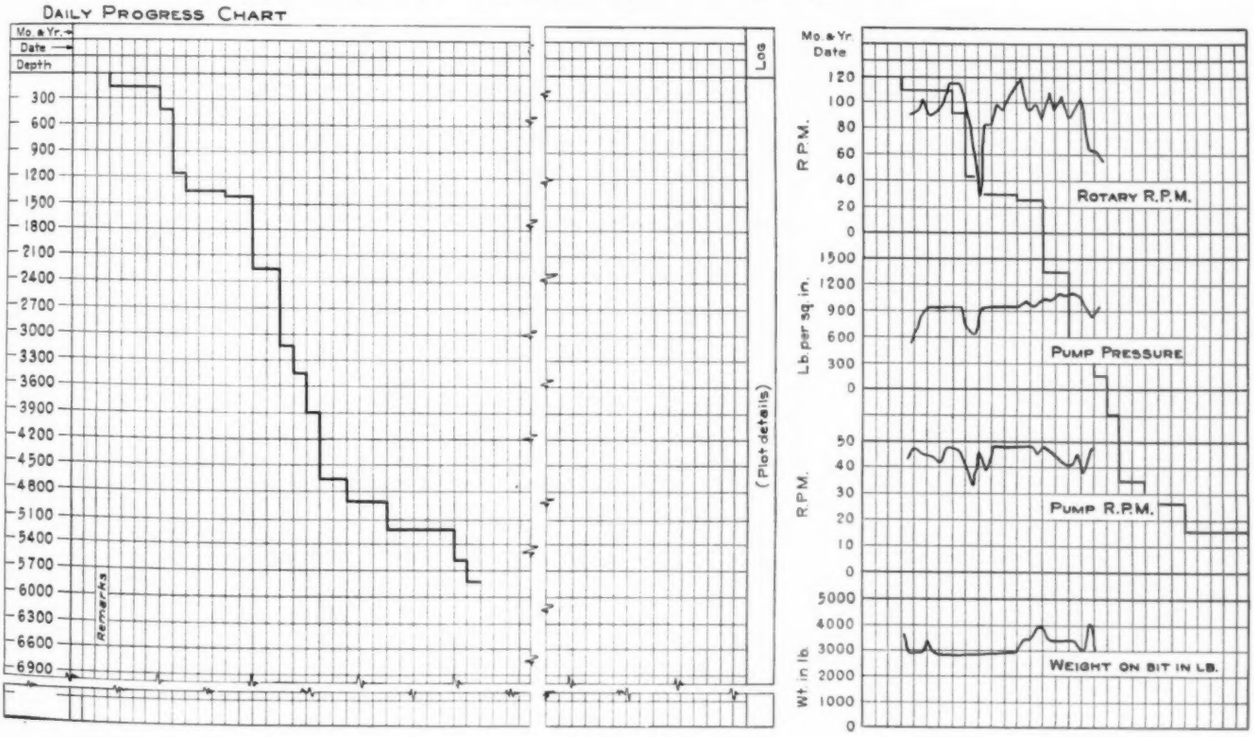
Although there are various types of so-called slim-hole rigs, many of them designed for relatively shallow drilling, the type used for drilling the holes referred to in this article was designed for drilling to a depth of 9000 ft. with 3½-in. drill pipe. In general, such a rig is powered with two 225-hp. engines, compounded, and driving a regular 27½-in. oil-bath rotary table through an 8-speed drawworks, and also driving a 7¼-in. by 15-in., 250-hp. slush pump at 60 s.p.m. rated speed. A conventional 136-ft. derrick with 26-ft. base is ordinarily used. A compact utility unit was assembled, which is powered by an 85-hp. engine driving through a lineshaft the various units such as generator, compressor, washdown pump, and a 6-in. by 12-in. power pump for jetting mud. The latter pump also may serve as a standby for the regular slush pump. The entire utility assembly is mounted on skids fabricated of 10-in. pipe, in which compressed air is stored. Rectangular steel mud tanks are also mounted on skids.

Advantages of Slim Holes

Subsurface geophysical data from any one test hole do not reveal precisely the location or degree of faulting. For this reason it may be desirable to drill several low-cost holes on a prospect to determine the general geological conditions, as well as the presence or absence of oil in the formation drilled. If results are sufficiently encouraging to warrant a deeper test, then such a test could probably be located more favorably from evidence obtained. On the basis of factual data as presented in the tables accompanying this article it is believed that slim holes can be drilled to a depth of 9000 ft. at an average cost of between one-third and one-fourth that of the average exploratory well. This assumes average drilling conditions and the use of a Diesel-mechanical rig.

From these slim holes electrical logs and side-wall samples can be obtained, and if a productive sand were found, it could be produced. Aside from these advantages and savings, there is an appreciable reduction in the costs of transportation and rigging-up, and of providing piling or mat foundations in a marine area.

Fig. 2. Charts used to record and correlate: (a) depth progress; (b) formations penetrated; (c) rotary table speed; (d) pump pressure; (e) pump speed, and (f) weight on bit



On the basis of analyses of data assembled it is indicated that, for similar drilling conditions, the rate of drilling or time required to drill to a given depth varies as the square of the diameter of the hole after surface casing has been set.

In the table (Fig. 6) pertinent data on wells of different sizes are given, classified as to hole size after surface pipe is set. In the semi-slim hole, an 8⅝-in. hole was drilled through 9⅝-in. surface casing. This semi-slim hole was not an exploratory hole, but was drilled to produce oil in an old field. A singular observation on this semi-slim hole was that it was drilled entirely with drag bits, but in the 12 or 13 big holes previously drilled considerable rock-bit digging was encountered. The wells selected represent as nearly similar drilling conditions as possible, for sake of comparison. One of the most interesting phases of this analysis is the uniformity of the actual cubic feet of formation cut per hour, which, when translated into lineal feet per hour, shows the true value of the small-diameter hole. Major fuel economies are effected because of the shorter time required to drill the hole, and because of the saving in fuel resulting from the use of Diesel engines.

Limitations and Deficiencies

There are certain limitations or defects restricting the use of the mechanical slim-hole rig, but they are not insuperable. Power slush pumps must be used with this type of rig. There is a radical difference in mud conditions obtaining in the Gulf Coast region as

Fig. 3. Time analyses of operations on individual wells

DRILLING WELL ANALYSIS
Gulf Coast

Operation	A-1	A-2	A-3	B-1	C-1	C-2	C-3	D-1	Total hrs.	Percent of total
Rigging up after spudding	325.00	61.00	38.00	46.00	0	0	14.25	7.00	491.25	2.93
Drilling	1,291.00	1.027.50	787.25	1,067.00	415.75	289.25	330.75	365.00	5,573.50	33.01
Reaming	310.00	229.00	35.50	162.50	58.75	12.50	9.00	51.75	869.00	5.15
Coring	96.00	17.00	90.75	27.75	0	0	0	0	231.50	1.38
Fishing bit plug and core barrel	216.00	0	64.25	89.50	0	0	0	0	369.75	2.19
Installing new equipment	20.00	0	0	13.50	0	0	0	0	33.50	.20
Repairing rig	312.00	91.00	40.50	103.50	39.75	21.25	44.75	28.50	681.25	4.05
Round trip and changing bit	720.00	409.00	198.50	446.25	101.75	75.75	69.50	142.50	2,163.25	12.81
Fishing	250.00	0	68.25	0	0	0	24.00	52.00	394.25	2.34
Setting casing	133.00	68.75	51.00	17.50	16.00	26.00	19.00	35.50	366.75	2,18
Waiting on cement	375.00	241.50	254.00	120.00	116.50	99.50	100.50	208.00	1,515.00	8.98
Deviation surveys	22.00	17.50	19.00	15.50	8.00	4.50	8.00	10.00	104.50	.62
Mixing mud	167.00	91.50	0	4.00	9.00	0	0	0	271.50	1.64
Circulating mud	334.00	108.25	27.75	34.25	15.25	14.00	9.50	25.25	568.25	3.37
Changing and repairing drill pipe	83.00	48.00	24.00	.17.50	8.50	0	7.00	.50	188.50	1.12
Electrical logging	26.00	10.00	15.00	11.75	13.75	5.00	13.00	24.25	118.75	.71
Waiting on tools	162.00	17.00	8.00	22.00	0	3.50	14.50	17.25	244.25	1.45
Waiting on orders	0	492.00	0	0	1.00	21.00	20.00	0	534.00	3.17
Waiting on weather	20.00	.25	0	4.50	1.25	0	0	0	26.00	.16
Waiting on fuel or water	0	3.50	0	0	0	0	0	0	3.50	.02
Repairing pumps	8.00	48.75	1.00	14.75	23.75	44.00	28.75	61.50	230.50	1.37
Restringing blocks	48.00	33.00	14.00	22.50	4.00	25.50	2.75	7.25	157.00	.94
Miscellaneous	91.00	201.00	20.25	73.50	53.00	43.25	40.75	53.00	575.75	3.42
Perforating and drill-stem testing	205.00	0	0	0	0	0	0	19.50	224.50	1.34
Lay down drill pipe and abandon	296.00	136.50	0	120.50	25.75	59.00	132.00	0	769.75	4.57
Completion	0	0	0	0	0	0	0	144.00	144.00	.85
Total	5,510.00	3,352.00	1,757.00	2,434.25	911.75	744.00	888.00	1,252.75	16,849.75	99.97
Date completed or abandoned	3-30-37	3-7-38		10-7-37	7-16-38	9-23-38	12-4-38	1-31-39	Totals	
No. days spud-in to complete or abandon	230.00	140.00	75.00	103.00	39.00	31.00	37.00	52.56	707.56	
Total ft. drilled	10,146.00	9,820.00	8,282.00	9,445.00	8,293.00	7,989.00	8,051.00	7,451.00	69,487.00	
Ft. drilled per day (total time)	44.00	65.00	114.30	90.20	212.00	257.70	217.50	141.50	98.30	
Actual ft. drilled per hour	7.80	9.57	10.53	8.84	20.00	27.62	24.30	20.42	12.50	
Total cu. ft. of formation cut	12,936.00	9,470.00	8,647.00	6,740.00	4,202.00	2,592.00	3,619.27	4,313.00	52,515.27	
Total cu. ft. per day	56.20	62.70	115.30	65.80	107.74	115.90	97.80	81.95	74.50	
Actual cu. ft. per hour	9.30	9.22	11.00	6.22	10.11	12.42	10.90	11.82	9.43	
Bit changes including core bits	135.00	82.00	41.00	94.00	26.00	18.00	19.00	35.00	450.00	
No. wire-line cores	243.00	0	69.00	76.00	0	0	0	0	388.00	
No. regular cores	11.00	5.00	1.00	0	0	0	0	0	17.00	
Avg. footage per bit	75.00	120.00	202.00	102.50	318.96	443.83	423.50	212.90	154.50	
No. ft. cut with wire-line core bbl	576.50	0	484.00	156.00	0	0	0	0	1,216.50	
No. ft. recovered with wire-line core bbl	397.25	0	424.00	115.08	0	0	0	0	936.33	
Percent recovery	69.2	0	87.50	73.80	0	0	0	0	77.20	
No. ft. cut with regular core bbl	77.00	95.00	18.00	0	0	0	0	0	190.00	
No. ft. recovered with regular core bbl	55.16	86.00	.50	0	0	0	0	0	141.66	
Percent recovery	71.50	90.50	.28	0	0	0	0	0	74.50	
Man-hrs. to rig up, move mat'l., ready to spud	2,930.00	3,737.00	3,053.00	2,570.00	1,865.00	1,609.00	2,045.00	2,142.00	19,951.00	
Man-hrs. to erect derrick and structures	991.00	606.00	1,736.00	986.00	1,038.00	488.00	688.00	288.00	6,821.00	
Piling man-hours	*1,835.00	0	0	2,470.00	0	0	0	906.00	5,211.00	
Total man-hrs. to spudding	5,756.00	4,343.00	4,789.00	6,026.00	2,903.00	2,097.00	2,733.00	3,336.00	31,983.00	

*Does not include piling contract.

NOTE: EXTRA LARGE HOLES
A-1—Casing: 18⅝-in. surface at 1400 ft.; 13⅜-in. at 4600 ft.; 9⅝-in. at 7700 ft.
A-2—Casing: 13⅜-in. surface at 2421 ft.; 9⅝-in. at 7734 ft. (heaving shale well)
A-3—Casing: 13⅜-in. surface at 2075 ft.; 9⅝-in. at 7617 ft.

NORMAL HOLE
B-1—Casing: 10¾-in. surface at 2100 ft.

SLIM HOLES
C-1—Casing: 8⅝-in. surface at 2006 ft.
C-2—Casing: 8⅝-in. surface at 1950 ft.
C-3—Casing: 8⅝-in. surface at 2015 ft.

SEMI-SLIM HOLE
D-1—Casing: 9⅝-in. surface at 1390 ft.

OPERATIONS—HOURS	Percent of totals			
	A wells	B well	C wells	D well
Rigging up after spudding	3.99	1.86	.56	.56
Drilling	29.23	43.80	40.70	29.10
Reaming	5.42	6.62	3.15	4.13
Coring	1.91	1.11	0	0
Fishing bit plug and core bbl.	2.63	3.65	0	0
Installing new equipment	.19	.54	0	0
Repairing rig	4.17	4.22	4.15	2.27
Round trip and change bit	12.51	18.95	9.74	11.40
Fishing	3.00	.11	.94	4.15
Setting casing	2.38	.71	2.39	2.83
Waiting on cement	8.19	4.90	12.42	16.60
Deviation surveys	.55	.63	.84	.80
Mixing mud	2.44	.15	.35	0
Circulating mud	4.44	1.43	1.52	2.02
Changing and repairing drill pipe	1.46	.72	.61	.04
Electrical logging	.48	.11	1.24	1.93
Waiting on tools	1.76	.88	.71	1.38
Waiting on orders	4.62	0	1.65	0
Waiting on weather	.19	.16	.05	0
Waiting on fuel or water	.03	0	0	0
Repairing pumps	.54	.62	3.79	4.90
Restringing blocks	.89	.92	1.27	.57
Miscellaneous	2.94	3.00	5.37	4.23
Perforating and drill-stem test	1.93	0	0	1.56
Lay down drill pipe and abandon	4.07	4.90	8.53	0
Completion	0	0	0	11.50
COSTS				
Coring costs	5.13	6.88	0	0
Reaming costs	3.79	4.62	3.07	4.98
Drilling costs	27.75	49.10	52.80	55.50
Fuel costs	17.35	23.65	3.48	3.32
Mud costs	11.50	2.67	1.88	1.77
Casing costs	35.90	13.26	38.80	34.35

Fig. 4. Analyses of costs for a group of wells

compared with California. It is interesting to note that in the 15,000-ft. well drilled in California, 3½-in. internal-flush drill pipe was used in drilling an 8⅝-in. hole, and that the circulating pressure was only 800 or 900 lb. and the breakout pressure 1100 to 1200 lb. This seems to be more or less typical of California conditions. In the Gulf Coast, however, a circulating pressure of 1000 or 1100 lb. is required with drill pipe of the same size in the same size hole at a depth of 7000 ft. In two 13,000-ft. wells on the Gulf Coast, the circulating pressure reached 1700 lb. and the breakout pressure 2200 lb. The difference is due to the type of formation being drilled. Many formations in the Gulf Coast consist of mud-

Fig. 5. Summary of costs of vital drilling operations

DRILLING OPERATIONS SUMMARY: COSTS

	A-1	A-2	A-3	B-1	C-1	C-2	C-3	D-1	Total dollars	Percent of total
Total cost all bits	7,355.00	4,956.27	1,655.06	3,551.94	714.90	448.19	448.19	1,165.05		
Total bit cost per ft	.725	.504	.198	.376	.086	.056	.056	.156		
Coring costs										
a. Bits	720.00	225.00	309.73	228.00	0	0	0	0	1,491.73	
b. Coring time	1,600.00	283.00	1,570.00	464.00	0	0	0	0	3,917.00	
c. Fishing bit plug and core bbl. time	3,060.00	0	1,075.00	1,490.00	0	0	0	0	5,625.00	
d. Round trip time with regular core bbl	1,100.00	583.00	100.00	0	0	0	0	0	1,783.00	
e. Wire line cores at $17.50 each	4,260.00	0	1,207.50	1,330.00	0	0	0	0	6,797.50	
f. Rental coring reel at $5.00 per day	350.00	0	250.00	520.00	0	0	0	0	1,120.00	
Total coring cost	11,099.00	1,091.00	4,512.23	4,032.00	0	0	0	0	20,734.23	4.64
Reaming costs										
a. Full hole reaming time	5,160.00	3,825.00	587.00	2,710.00	980.00	208.00	152.00	863.00	14,485.00	
b. Rat-hole reaming time	1,100.00	83.00	0	0	0	0	0	0	1,183.00	
c. Underreaming time	0	0	0	0	0	0	0	0	0	
Total reaming costs	6,260.00	3,908.00	587.00	2,710.00	980.00	208.00	152.00	863.00	15,668.00	3.51
Drilling costs										
a. Time on bottom making hole	21,505.00	17,124.00	13,130.00	17,800.00	6,925.00	4,830.00	5,520.00	6,085.00	92,919.00	
b. Round trip time	12,000.00	6,820.00	3,290.00	7,450.00	1,695 00	1,264.00	1,158.00	2,378 00	36,055.00	
c. Drilling bit cost	7,355.00	4,731.27	1,345.33	3,551.94	714.90	448.19	448.19	1,165.05	19,759.87	
Total drilling costs	40,860.00	28,675.27	17,765.33	28,801.94	9,334.90	6,542.19	7,126.19	9,628.05	148,733.87	33.35
Fuel costs										
a. Oil—price per bbl	1.35	0	at dock 1.60	1.35	1.75	1.75	1.75	1.62		
b. Oil—total cost	22,498.38	0	14,591.00	12,500.00	466.92	283.50	389.28	443.68	51,172.76	
c. Barge rental rate	mo. 400.00	0	0	mo. 400.00	da. 5.00	da. 5.00	da. 5.00	da. 5.00		
d. Barge total rental	2,400.00	0	0	1,200.00	30.00	20.00	30.00	30.00	3,710.00	
e. Towing cost	396.00	0	0	198.00	120.00	80.00	100.00	100.00	994.00	
f. Gas—cost per M. cu. ft.	0	.15	0	0	0	0	0	0		
g. Gas—total cost	0	16,808.20	0	0	0	0	0	0	16,808.20	
Total fuel cost	25,294.38	16,808.20	14,591.00	13,898.00	616.92	383.50	519.28	573.68	72,684.96	16.25
Mud costs										
a. Material costs	12,337.00	20,171.05	798.00	1,507.00	485.50	123.32	60.31	307.34	35,789.52	
b. Mixing mud time cost	2,680.00	1,523.00	0	67.00	150.00	0	0	0	4,420.00	
Total mud cost	15,017.00	21,694.05	798.00	1,574.00	635.50	123.32	60.31	307.34	40,209.52	8.99
Casing costs										
a. Material	44,378.00	27,705.30	26,546.40	5,505.00	3,396.93	3,331.31	3,897.68	9,388.22	124,148.84	
b. Running and cementing time	2,180.00	1,143.00	850.00	292.00	267.00	433.00	317.00	592.00	6,074.00	
c. Waiting on cement time	6,230.00	4,020.00	4,230.00	2,010.00	1,946.00	1,655.00	1,675.00	3,465.00	25,231.00	
								13,445.22		
							less	7,476.62	for 5½" oil	string.
Total casing cost	52,788.00	32,868.00	31,626.40	7,807.00	5,609.93	5,419.31	5,889.68	5,968.60	147,977.22	33.25
Grand total	151,318.38	105,044.82	69,899.96	58,822.94	17,177.25	12,676.32	13,747.46	17,340.67	446,007.80	

A-1, A-2, A-3 extra large holes.
B-1 normal hole.
C-1, C-2, C-3 slim holes.
D-1 semi-slim hole.
Note: Time figured as rig time at $400.00 per day.

making shale; also, extremely high pressures and gas pockets are encountered, necessitating use of heavier mud. For these reasons, even though drastic attempts are sometimes made to reduce the viscosity and gel strength of mud, the difficulty appears to be an inherent one. It might be desirable in drilling below 7000 ft. to use high-pressure low-volume slush pumps.

Magnetic clutches or hydraulic couplings, if adopted, might reduce or eliminate present difficulties resulting from the use of friction clutches. Their use might tend also to minimize present difficulties of drilling crews in maintaining proper relations between engine speed, pump speed, and pump pressure.

There is also the minimum limit to the size of hole drilled. One major company has successfully drilled 6⅛-in. hole below the surface pipe. This probably represents the present desirable minimum in size of hole. To maintain a straight hole, a somewhat larger hole would be preferable, such as 7¾-in. diameter; a hole of this size would permit the use of 6-in. O.D. drill collar, making it possible to obtain sufficient weight in the drill collar to maintain tension on the drill stem while drilling, to obtain a straight hole, and thus to reduce the hazard of twist-offs. It would also permit running a small casing string for production.

Fig. 6. Data on wells of different sizes (classified as to hole size after surface pipe is set)

Well	Depth, ft.	Total days	Total cu. ft. formation	Bit changes	Ft. per bit	Actual cu. ft. per hr.	Actual ft. per hr.	Bit cost per ft.	Coring cost per ft.	Reaming cost per ft.	Drilling cost per ft.	Fuel cost per ft.	Mud cost per ft.	Casing cost per ft.	Cost per ft.	Type of rig
Extra large hole																
A-1	10,146	230	12,936	135	75	9.30	7.8	.725	1.10	.62	4.00	2.50	1.48	5.20	14.90	Steam—fuel oil
A-2	9,830	140	9,470	83	120	9.22	9.57	.504	.11	40	2.92	1.71	2.20	3.33	10.67	Steam—purchased gas at 15¢
A-3	9,636	192	9,470	79	134	7.22	8.07	.465	.58	.155	3.30	2.97	1.57	3.50	12.07	Steam—fuel oil
Normal hole																
B-1	9,445	103	6,740	94	102.5	6.22	8.84	.376	.425	.286	3.04	.52	.167	.825	6.76	Steam—fuel oil
Slim hole																
C-1	8,293	39	4,202	26	318.96	10.1	20.00	.086	0	.118	1.12	.074	.076	.675	2.06	Diesel portable
C-2	7,989	31	3,592	18	443.00	12.42	27.62	.068	0	.026	.83	.048	.015	.68	1.60	Diesel portable
C-3	8,051	37	3,619	19	423.50	10.9	24.3	.058	0	.019	.89	.065	.007	.735	1.72	Diesel portable
Semi-slim hole																
D-1	7,451	35	4,313	35	213.00	11.8	20.4	.156	0	.115	1.30	.077	.041	.799*	2.33	Diesel portable

*No oil strings included in casing column.

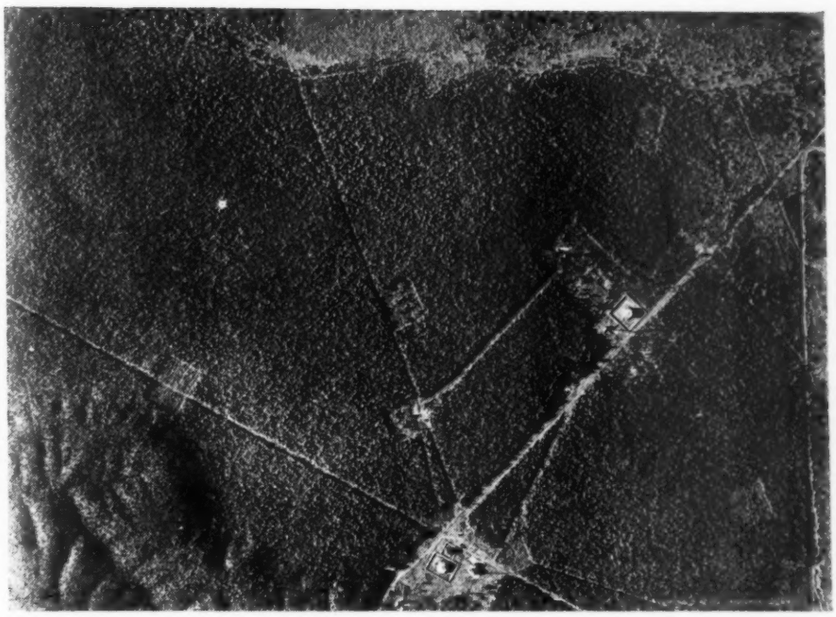
Fuller's Earth Production Declined in 1938

CONFIRMING the recent trend to use smaller quantities but better qualities of bleaching clays, U. S. Bureau of Mines figures for Fuller's earth consumption in the United States show a 24 percent decline in 1938. Domestic production of Fuller's earth or natural bleaching clays declined to 170,852 short tons valued at $1,707,869, compared with 226,165 tons worth $2,296,094 in 1937, and 230,814 tons worth $2,264,978 in 1936. Imports, which have been unimportant in recent years, averaging less than 1½ percent of annual consumption during the last decade, also decreased in 1938, and exports increased, though not importantly.

The predominant use of Fuller's earth is in oil refining, and shipments of Fuller's earth from domestic mines paralleled expansion of the petroleum industry for several decades, increasing steadily from an annual average of 40,000 tons before the World War to a peak of 335,644 tons in 1930. Following a temporary setback in the early years of the general business depression, petroleum refining resumed its strong uptrend, whereas the use of Fuller's earth failed to increase after 1932. The failure of Fuller's earth consumption to keep pace with the greater activity in petroleum refining is due in part to a relative reduction in the output of lubricants, which is the branch of the refining industry that uses the largest amount of bleaching clay. New methods of processing that require much smaller additions of Fuller's earth, and the substitution of other bleaching materials — first, activated earths and in 1938, bauxite—are even greater depressing factors, however.

The United States is by far the largest producer of Fuller's earth and normally exports as much as 5 percent of its domestic production. Exports of Fuller's earth are not separately reported in the official statistics of the United States, but since 1923 domestic producers have reported their foreign shipments to the U. S. Bureau of Mines. In 1938, such shipments aggregated 10,046 short tons having an average value of $8.08 compared with 8,104 tons worth $8.76 a ton in 1937 and a maximum quantity of 21,264 tons in 1929 when the average value was $12.15 a ton. In 1927, when 12,287 tons was exported, the average value was $15.61. Canada has been the most important single export market in recent years, but shipments have been made to oil refineries throughout the world.

The average value of the Fuller's earth produced in the United States in 1938 was $10 a ton f.o.b. mines compared with $10.15 in 1937, a recent low of $9.28 in 1933, and a high of $19.51 in 1920. Prices vary according to particle size, fine material suitable only for contact use being relatively cheap. The *Engineering and Mining Journal* quotations for Georgia or Florida earth, f.o.b. mines have remained unchanged for several years at $14.50 per short ton for 30- to 60-mesh, $14 per ton for 15- to 30-mesh, $10 for 200-mesh up, and $7 for 100-mesh up.



Field operations in densely wooded sections are best charted by aerial mapping
—(Photo courtesy Fairchild Aerial Surveys, Inc.)

By
HERBERT THAYER
BRUCE

A PETROLEUM ENGINEER EXCLUSIVE FEATURE

Recent Improvements in Technique of Aerial Photography

Part 1

Precise charting over unknown areas now made easy by newly developed instruments

AERIAL photographic surveys are not new to the petroleum industry. They have been used to good advantage in reconnaissance work for many different purposes. In fact, the petroleum industry was among the first to use this industrial application of aviation that came into prominence during the early '20s. Although many engineers and executives in the petroleum industry are conversant with the use of the aerial map and its engineering application not many have had an opportunity to learn much of the technique by which aerial survey maps are constructed. The development of many new instruments and improved processes in recent years has increased materially the accuracy and value of aerial photographic surveys. Consequently, a discussion of aerial work explaining the use of these new instruments and processes should prove of interest to engineers and others in the petroleum industry.

Aerial photography first was employed in the World War. Crude and ineffectual at that time, much of the advancement and invention that has resulted in the modern scientific processes and equipment may be credited to Sherman M. Fairchild, president of Fairchild Aerial Surveys. Based on his observations and experiences during the War, Fairchild designed a radically different aerial camera, the completed model of which was introduced commercially in 1920. Among its many unusual features was the first dependable high-speed between-the-lens shutter, its parts were interchangeable, and metal was used in all possible places in its construction. Considering the many classifications of terrain that must be photographed with precision, the quality and flexibility of camera equipment is important. Today aerial cameras are available with lenses capable of producing reconnaissance and survey maps with contour intervals as close as 5 feet. Early cameras were of the single-lens type; modern interchangeable lens cones of varying focal lengths permit a maximum of flexibility. Multi-lens cameras have now become standard for most types of vertical photographic work. Because this camera produces prints in the shape of a Maltese Cross, experiments were made with filling in the blank spaces of the print by mak-

HERBERT THAYER BRUCE

as an officer in the World War was first attracted to aviation as a hobby. Out of this grew his interest in aerial photography. Bruce is an avid student of modern advancements in various industrial and professional fields. Following the war, Bruce was associated with investment banking interests in New York City. Since 1930, he has devoted his time to writing. His keen analyses of modern trends have appeared in a number of national magazines.

Configurations of complex topography are best studied with the aid of aerial maps

—(Photo courtesy Fairchild Aerial Surveys, Inc.)

ing one exposure and then quickly turning the camera 45 degrees to make another exposure. Not proving practicable, later experiments were made by placing two five-lens cameras in parallel on a single mount, one camera turned 45 degrees from the other. These units, operating simultaneously, speeded-up work, greatly reduced cost, and simplified control. The Fairchild multi-lens transformer, as the instrument is called, was designed particularly to meet the requirements of precise aerial mapping. The ten-lens mapping camera is capable of use at altitudes that require the use of oxygen by the operators in the rarified atmosphere. Film magazines for the single-lens camera, each containing a roll of 110 exposures or more, may be changed while in flight in 15 to 20 seconds.

The photographer's cockpit in the airplane resembles an electrically-fitted laboratory more than a flying photographic studio. For survey purposes the camera is installed vertically, aiming downward through an opening in the cabin floor; for oblique (over-the-side pictures) the camera is held by the operator or held in a flexible mount designed to absorb the plane's vibrations. When mounted vertically a special view finder is used, situated between the camera and the operator, and also aimed vertically downward through the cabin floor. Use of the range finder enables the photographer to see what the camera is photographing and to figure drift and overlap. The camera itself is supported by a gimbal mount by which it may be adjusted to any angle. Certain operations of the camera are actuated by an electric motor powered by a generator driven by the plane's engine. This motor actuates the intervalometer (the instrument that regulates the time interval between exposures, this time interval being the essence of the accuracy that insures overlapping), the shutter, and the film mechanism.

The average working altitude is from 15,000 to 25,000 ft. for survey mapping. The plane's construction and flying accuracy must conform to exceptional standards. The planes used are designed with a safety factor of 6 or 7 based on the stress to which they might be subjected under the worst imaginable flying conditions.

Planes of large or small size are used depending on the requirements of the particular survey, the territory over which the flight must be made, and the atmospheric conditions with which pilot and photographer must contend. Each plane, whatever its make, whatever its type, must permit an unobstructed view so the pilot may easily follow ground features below and be able to see far enough ahead to keep lined on prominent landmarks selected as flight guide-lines. The plane must possess high-lift characteristics in order to gain altitude in a short time to permit more efficient use of the time aloft in actually making the survey.

In the early days of aerial mapping, Fairchild constructed a plane that embodied all the desired features. Equipped with folding wings, which made it easy to house in small local airports, it was the first cabin plane in this country that housed the pilot inside the cabin and up front. The instrument board included a sensitive altimeter, directional gyro, artificial horizon, and other aerial instruments that aided the pilot in flying.

A recent development of great value to aerial surveying is an instrument designed initially for survey work in New Guinea. The instrument is called the solar navigator. Airplane navigation is one of the most vexing problems encountered in mapping areas of which no maps exist. This ingenious instrument consists of a drift indicator situated in the floor of the plane's cabin, stabilized by a gyroscope to offset the tendency of the ground images to wander over the drift field as the plane rolls. The drift indicator is suspended from a sun compass in the ceiling of the cabin. The sun compass registers by remote control on a galvanometer mounted on the pilot's control board. The desired course is determined by the drift lines of the drift indicator and the axis of the sun compass. This combination registers the degree of departure on the pilot's instrument panel when he veers from the desired course. Thus, it solves automatically the problem of varying winds and drifts. The pilot changes direction as the galvanometer needle commands. Accuracy of the instrument depends on careful adjustment of the drift indicator in order that the image of the ground objects on the glass move accurately along the drift lines.

Reconnaissance over large and unknown areas may now be controlled through use of the solar navigator. A plane may be piloted on any predetermined course to an accuracy of one-quarter degree. The value of the instrument may be appreciated when it is realized that the pilot in aerial mapping has the task of flying successive "strips" each from 60 to 120 miles long so that each "strip" parallels the last without any gaps between. Imagine flying 20,000 feet above the ground over an unknown territory trying to keep the ship going down an imaginary line while constantly changing its heading to compensate for varying wind velocity and direction. Added to this is often the further complication of haze or fog that obscures distant landmarks from the pilot's vision.

EDITOR'S NOTE: *This discussion of aerial photography will be concluded in a future issue.*

Regulatory Equipment to Control Pressure in Gas Distribution System

Combination of devices permits automatic remote control and reduces leakage losses

By

ROBERT M. HUTCHISON

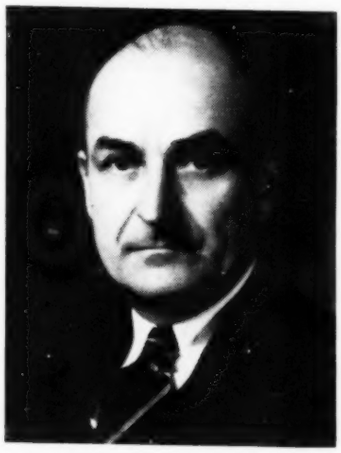
Chief Engineer, Houston Natural Gas Company

GAS distribution engineers who remember the days of stabbing stop-cocks, fighting pressure, and bung hole taps, have real cause to wonder how they got along, but thanks to progressive manufacturers and man's insatiable desire to improve, these bad practices and many others are things of the past. It formerly required days of planning and preparation to get everything ready to cut a line or make a hot tap, but now these things are done daily in a routine manner and no one is the worse for wear.

The same may also be said for pressure regulation. There was a time in the not too far distant past when regulators were just a piece of equipment, and if the operator could hold within 10 percent of the pressure desired, he really had something.

Many were the times that a man had to be stationed at each regulator in order to assure Mrs. Consumer she would have enough hot water to wash Johnnie's face before he went to school, or enough heat to cook Daddy's biscuits before he left for work. This condition, at one time, applied definitely to the Gulf Coast country because the weather in that area has always been most fickle; in fact, so much so that the poor distribution-man never knows what to do. It is not unusual to leave home in shirt sleeves and need an overcoat before arriving at the "Gas House," a transition that keeps the gas man on the jump, and causes pressures to romp all over the chart.

Naturally, this set men to thinking, and along came intermediate pressure distribution. This seemed to be the answer, and it was in one sense of the word. People now had enough gas, but the gas companies began having more "unaccounted for," and the distribution-man had a new problem. If he carried pressures high enough to put him over the hump when the "northers" hit, he increased his leakage, and if he didn't, his complaint crews wore out an extra set of tires. What he really needed was a means whereby he could carry the right pressure at all times, for this was the only way to keep both complaints and leakage at a minimum. Speaking in the vernacular, he wanted an instrument that could "beat the weather man to the draw." It had to be almost human; enough so, at least, to be conscious of heat or cold.



ROBERT M. HUTCHISON

is an alumnus of Pennsylvania State College—Has been affiliated with the Houston Natural Gas Company for the last ten years—Is the developer of the Hutchison Rapid Calculator for pipe-line flow and of the H. & H. By-Pass Type Odorizer.

Could such an instrument be built? That was the question. Some said yes; many said no. It was, and today the gas man can sit back and thumb his nose at Old Jack Frost or the noonday sun, because he can now have what he wanted.

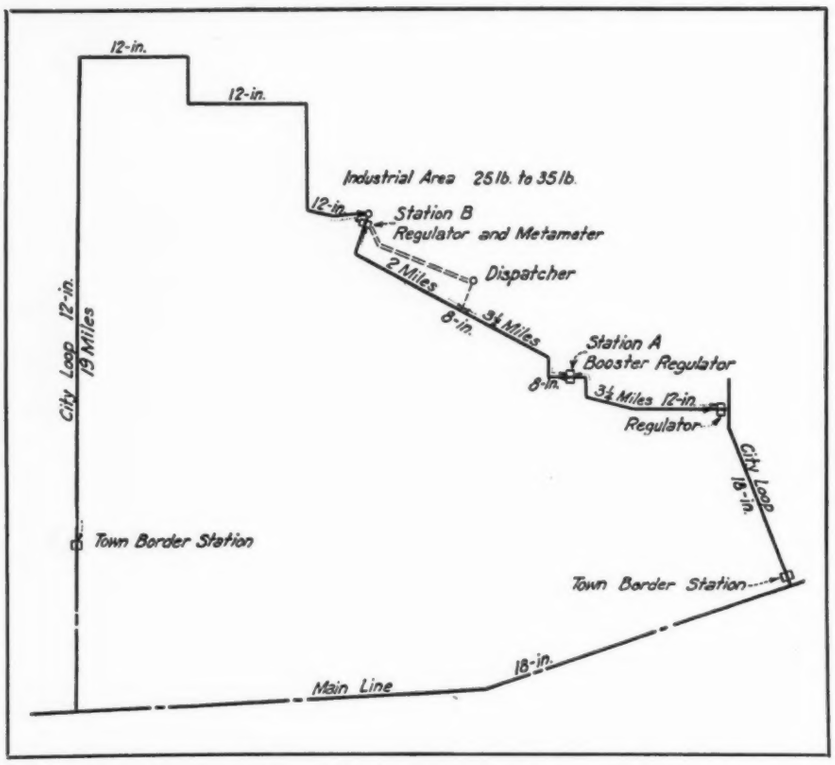
This article was written to describe an installation giving positive pressure control from remote points. Refer to the accompanying sketch. It represents a city loop that is being supplied from a large cross-country gas main.

The industrial area is situated close to the center and is fed from a 12-in. line from the left, and a combination 8-in., 12-in., and 18-in. line from the right. It is desired to maintain a pressure of 25 to 35 lb. gauge in this industrial area, depending upon the atmospheric temperature.

There was a time when the dispatcher tried to regulate this pressure from the town border stations, but inasmuch as an 8-in. line is feeding into a 12-in. it was not known in which direction the gas was flowing. It was, of course, possible to install a regulator that would feed from the 8-in. line into the 12-in, and this was done at Station B, but the pressures had to be raised and lowered manually. To compensate for these increases and decreases, which were reflected in the 8-in. line, a workman had to be stationed at Station A. This poor fellow had to get up about 5 a.m. and many times didn't get home until late at night. Then, too, it was not definitely known that the pressure being carried on the 8-in. line was in exact accordance with the volume demand.

The operators of this system had had some experience with the booster regulator, so it was decided to install one at Station A, because it was known that this piece of equipment would raise and lower the pressure in the 8-in. line automatically in exact accordance with the gas demand; hence, the man at Station A was eliminated.

Station B, however, was still a problem. How could that pressure be raised or lowered without sending some one to do it? The answer came in the form of the metameter and remote recording pressure gauge. This equipment was attached to the regulator at Station B



Sketch representing a city loop that is being supplied from a cross-country gas main

and by means of two telephone wires the pressure is controlled by the dispatcher, who is two miles away. When change of pressure in the industrial area is needed he knows it immediately because the recording gauge, showing the trend, is right before him, and he has but to touch the electric switch to raise or lower the pressure at the rate of 1 lb. per minute. Now what happens at Station A when the dispatcher makes a change at B? The booster regulator will increase or decrease the pressure at Station A by an amount sufficient to compensate for the line loss, and the dispatcher can note the change on a second recording gauge.

This method of operation, therefore, guarantees the correct pressure at all times because the regulator at Station A will not boost unless the load demands it. The results are, then: less leakage, simplified operation, correct pressure, closer observance of operating pressure, and elimination of manual control, any one of which is a distinct advantage.

The use of the metameter or the booster regulator is by no means restricted to that function herein described, nor is it the intention of this article to claim any credit for the development of either, but to the writer's knowledge, the two instruments have never been used together in a similar combination and it is hoped that this explanation will prove beneficial to others in the industry.

Gas Line Laid From Katy Field, Texas

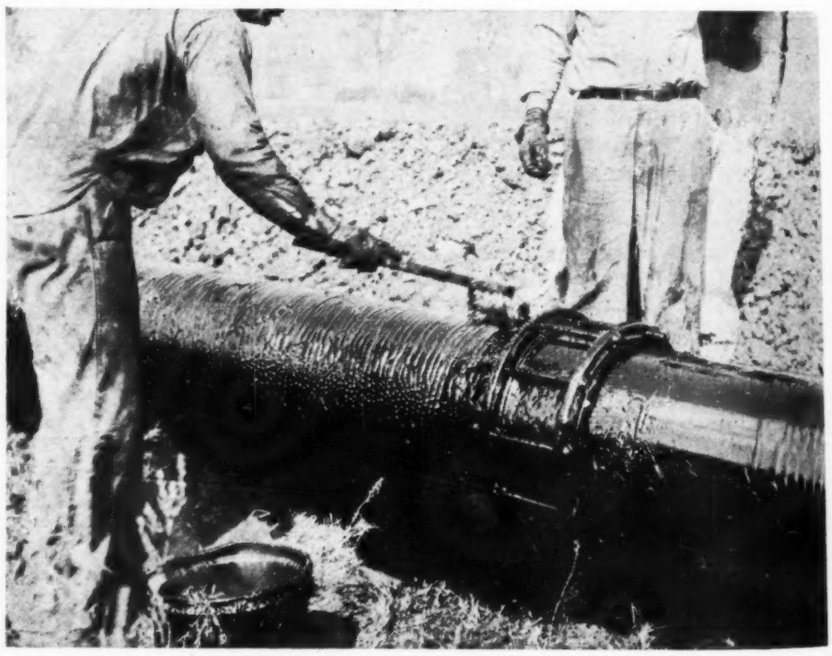
TO transport natural gas from the Katy field, Waller County, Texas, to the Houston market, the United Gas Pipe Line Company has laid a 43-mile line that connects with the Goodrich-Houston main line of the company. The line is a combination of 18 miles of 10-in. pipe, 11 miles of 12-in., and 14 miles of 16-in. In addition three miles of 8-in. laterals were laid.

Steel pipe was used, a part of which was new and the rest reconditioned stock. The new stock was manufactured by the Youngstown Sheet and Tube Company. The length of pipe sections was 50 ft. and the joints were of composite construction, both welded and Dresser coupled for the 16-in. pipe; welded joints only for the 8-in., 10-in., and 12-in.

A total of 448 16-in. O.D. couplings equipped with Armored gaskets was used.

The line is designed for an average working pressure of 350 lb. per sq. in. and a maximum working pressure of 475 lb. per sq. in.

Applying coating to a coupled joint



Flow Schedules Essential Part of East Texas Operations

PETROLEUM ENGINEER EXCLUSIVE FEATURE

Continuous and uniform gas load to natural gasoline plants achieved by systematic methods

By J. C. ALBRIGHT

THE East Texas field is a problem for natural gasoline plant operators. The daily allowable oil production averages between 370,000 and 375,000 bbl., produced from almost 25,000 individual wells capable of producing this amount of oil in a very short time. Some wells, if permitted to flow freely, could produce several thousand bbl. of oil per day. On a basis of a ratio of 300 cu. ft. of gas per bbl. of oil, the amount of casing-head gas available for processing will exceed 111,000,000 cu. ft. per day. This gas, if properly controlled between the Christmas tree and the gasoline plant, contains as much as 5 gal. per M cu ft., not taking into consideration the butane and propane that may also be recovered. Inasmuch as the natural reservoir pressure is high and the oil flows from the sand readily, oil producers tend to flow the allowable production of each well or group of wells in the shortest period of time possible, and preference is given to daylight work. If some gas pops to the atmosphere through the separator stacks, it would seem to matter little, but while this large volume of gas is being vented to the air, the gasoline plants are working under a tremendous overload. Then, when the allowable oil has been produced, the wells are shut-in, and the gasoline plants are coasting along, receiving scarcely enough gas for use as engine fuel.

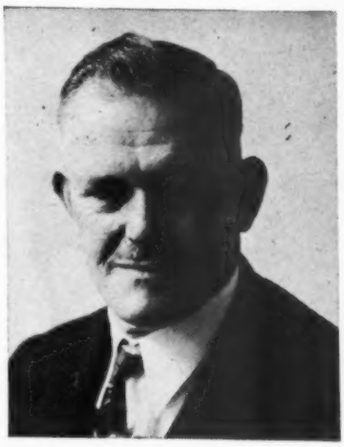
To make a gasoline plant pay under the present price structure, it is a well-known fact that there must be a continuous, almost uniform load throughout the day, and to achieve this result, East Texas gasoline-plant operators have devised a system of flow schedules for all wells connected to the gas-gathering system of the individual plant. The objective is to obtain the greatest amount of gas available without placing undue pressure upon separators and gathering lines.

By agreement between the gasoline-plant operators and the oil producers, the dispatchers have almost a free hand in determining when any well is to be opened, how long it is to flow, and upon what day or days of the week it must be shut-in.

Each plant must necessarily develop its own flow schedule. In planning the flow schedule it is within the province of the flow-schedule operator or dispatcher to supervise, to some extent the setting of flow tanks and oil and gas separators, to insure that the traps are elevated above the top of the tank battery so that a pressure approximating atmospheric may be maintained without interfering with the flow of oil from the well to the tanks. Tests indicate that the gasoline content of the gas varies widely, depending largely upon the pressure in the separators. Only 2 or 3 gal. of gasoline per M cu. ft. can be extracted if trap pressure exceeds 20 lb. gauge, but as much as 5 gal. can be obtained when atmospheric pressure or a slight vacuum is maintained on the separators.

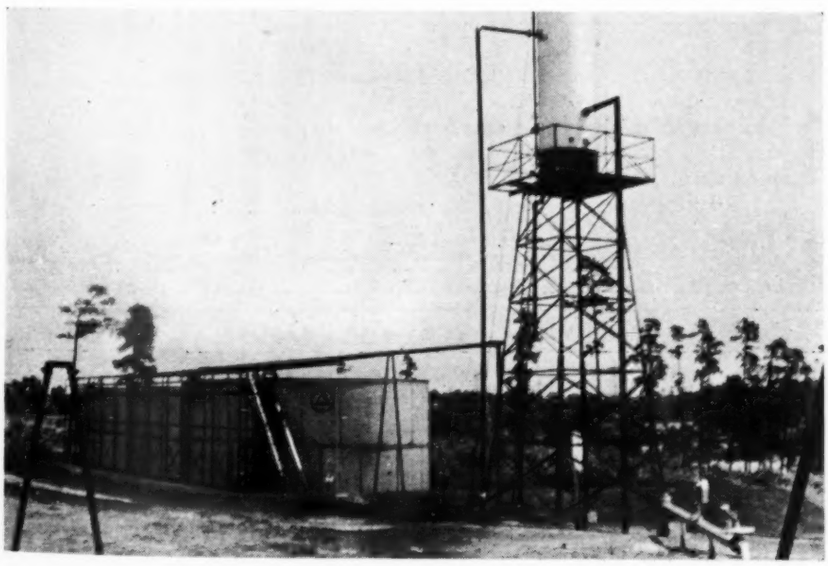
A large amount of "paper work" is required to maintain equitable flow schedules for a large number of wells, and as many as 2500 wells are connected to the gas-gathering system of some plants. In some sections of the field numerous individual operators each manage a few wells, and a few operate only two- or three-well leases. In sections where one operator manages many wells, the problem is much simpler.

An intensive study of the portion of

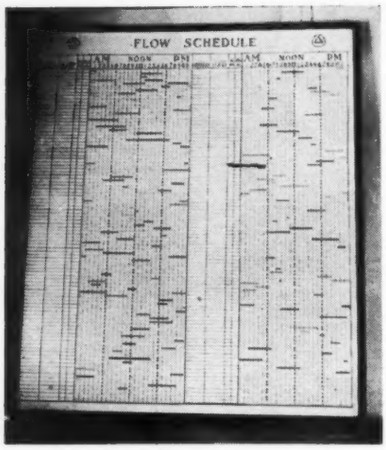


J. C. ALBRIGHT

after participation in the World War, was drilling superintendent for H. J. von Hagen in North Texas area, 1919-1921—With the Noble Oil and Gas Company, Burkburnett, Texas, in the natural gasoline and refining departments, from 1921 to 1923—Joined staff of the Dixie Gasoline Company in 1923 and became Texas manager—Employed by Phillips Petroleum Company in 1925 and was sent to New Mexico as special representative at Artesia where the company constructed a natural gasoline plant—Made state representative by that company in 1926—Left Phillips in 1929 and for a time operated as a consulting engineer, having offices at Brownwood, Texas—For last ten years has devoted practically all his time writing as a free lance for trade journals.



Some separators are elevated to obtain a pressure of about atmospheric without interfering with flow of oil



A typical flow schedule

the field from which the gasoline plant obtains its gas and a survey of the capacity of the gathering system mains and laterals under different conditions must precede the preparation of a schedule. The problem is solved on the basis of the number of wells connected to the individual headers, the flowing time being apportioned to obtain a constant volume of gas from all parts of the area throughout the full 24 hours. It is sometimes impossible to obtain close coöperation from individual well owners, and allowance is made for gas from these particular properties by leaving an opening in the schedule for the production from the wells involved, which automatically allows for an increased amount of gas at the time of day when these wells usually produce.

When Sunday and Saturday shut-downs are in force, the flow schedules are mimeographed to indicate which leases are to be shut-down on that basis (Form 1). Wells on major leases and on the leases of other co-operating producers are allocated definite hours for production, and the companies are provided with a schedule showing which leases are to be produced, and between which hours of the day. (Form 2.) Forms are made for each individual lease, giving precise directions for producing that particular property. (Form 3.) So that records may be available at the gasoline plant to indicate which wells are producing, and at what hours they are to be produced, forms are printed that show companies, leases, and number of wells on each lease, and space is provided on the form for allocating definite hours. (Form 4.) In addition to these forms and many others of a minor nature, there is sometimes installed on the wall of the office of the flow-schedule clerk a large board wherein colored strips of paper are inserted in slots opposite the name of the companies so that operations may be observed at a glance.

Without an adequate flow schedule, the successful operation of a gasoline plant would be almost impossible. More gas than could possibly be processed would be available one hour, but not enough for fuel the next. Results are now being obtained that more than justify the time and effort required to organize the system.

FORM 1

Shut down schedule of the ..... Company's leases
connected to the ..... Company's gasoline plant
for the month of July, 1938

Lease	*Shut-down dates*
Adrian-McCrary	July 5, 11, 12, 18, 19
Allison	July 5, 11, 12, 18, 19
Bolton-Whatley	July 8, 13, 14, 20, 21
Calvin	July 6, 15, 16, 22, 23
Castleberry "B"—Davis	July 5, 11, 12, 18, 19
* * * * * *	
Tuttle	July 5, 11, 12, 18, 19
Walker	July 8, 15, 16, 22, 23

Your full co-operation will be greatly appreciated.

.....COMPANY
EAST TEXAS GASOLINE PLANT

.....
Flow-schedule Clerk.

FORM 2

July Schedule
..... Oil & Gas Company
To
..... Gasoline Plant

DISTRICT NO. 1	
Castleberry	12 A.M. - 5 A.M.
Christian A, Harley A	11 A.M. - 4 P.M.
Harley B, McKinley C	7 P.M. - 12 P.M.
LaThropp B B	4 P.M. - 10 P.M.
Annie Lee McKinley D	8 A.M. - 3 P.M.
Stuckey Thrasher	2 A.M. - 8 A.M.
DISTRICT NO. 2	
Vonnie Calvin	3 A.M. - 8 A.M.
Custer-Skipper	7 P.M. - 12 P.M.

FORM 3

Company.....
Lease.....
Your flow schedule for the month of .....
is:
From ..... A.M. to ..... A.M.
From ..... P.M. to ..... P.M.
Thanks.
..... Gasoline Plant.

FORM 4

Company	Lease	Wells	Daily Gas	1	2	3	4	5	6	7	8	9	10	11	noon	1	2	3	4	5	6	7	8	9	10	11	12
Arkansas	Taylor																										
Atlantic	Harris																										
"	Smith																										
Gulf	Lacey																										
Humble	Harris																										

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Production Methods in the Rodessa Field

PART I

Many artificial gas-lift methods and various types of equipment being employed

By T. H. GIBBS
District Engineer, Standard Oil Company of Louisiana

GAS was discovered in the Rodessa field in 1930. Development was slow, only 19 wells having been completed by 1935 when oil was discovered. Since that date 1089 wells have been completed in this field, which is situated in the states of Louisiana, Texas, and Arkansas.

Structurally the field is a fault trap. There are three productive zones: the upper or Hill zone is a sand and produces only gas, whereas the next lower zone, the Gloyd or Caddo Levee Board, and the lowest zone, the Dees-Young, are both lime and produce gas at the crest of the structure and oil farther down the structure. The average depth of the wells is 6000 ft.

During the early development the field suffered from production at excessive gas/oil ratios and from excessive per well allowable production. Reservoir pressure was reduced rapidly, allowing migration of the gas from the cap into the structurally lower oil zone. Several proration orders were issued by the mineral conservation bodies of the three states. The present orders governing the three sections are similar with regard to prohibiting producing multiple zones from the same well. Individual oil well allowable production is based equally on acreage and reservoir pressure, a penalty provision being incorporated to reduce proportionately the allowable production of wells producing at a gas/oil ratio exceeding 2000 to 1. The order governing the Louisiana area provides that gas taken from an oil-producing formation by a gas well shall be equivalent volumetrically to the average per acre oil well allowable production of oil and gas combined. Computations are based on the average reservoir pressure. Enforcement of the orders has accomplished many beneficial results, such as preventing inter-zone pollution and drainage, and, most important, the conservation of reservoir energy.

Virtually all the wells in which water causes serious trouble are drilled on the down-dip or northern edge of the structure. A few old wells in the most productive area of the field were drilled too far into the Young zone and have produced water since completion. In some of these wells no effort has been made to plug the water zone. It might be added that only a few attempts to exclude bottom water have been successful.

T. H. GIBBS

has been employed by the Standard Oil Company of Louisiana for six years and has been stationed in the Rodessa field since 1936, ten months after the first oil well was discovered —Is a graduate petroleum engineer from Texas University — Also attended Louisiana State University— Before joining the staff of the Standard Oil Company of Louisiana he was with the Magnolia Petroleum Company.

Flowing production has contributed its own problem, the introduction of conservation and the resulting attention to reservoir-energy control having changed the former conception of production as involving nothing more than opening well connections to the stock tanks.

Wells in the last stage of natural flow are incapable of flowing against the back pressure imposed by surface choking. Such wells often flow at rates exceeding their legal limits for the time required to yield the allowable production for the month. Where high-pressure gas is available the wells can be "rocked" or "kicked-off". Elsewhere swabbing can induce flow. This practice can be continued until the reservoir pressure declines so low that it is exceeded by the weight of the lightened column of fluid, assuming, of course, that the volume of reservoir gas available is sufficient. Other operators, lacking either of these means, install "kick-off" collars or starting valves to utilize the built-up casing pressure of the well to start flow.

To flow wells in which low productivity results from low permeability rather than reduced static pressure, "stopcocking" has proved popular. This method consists of closing low-pressure wells completely for sufficient time to allow oil to enter the well bore and to allow pressure to build-up. The well is then opened for the length of time necessary to produce the accumulated oil. It is thought that this practice will result in greater ultimate recovery as the pressure in the reservoir is allowed to equalize through the drainage area between producing periods. Another benefit usually derived from this practice is a lower gas/oil ratio.

After natural flow in all its stages has ceased, by far the most extensively used method of artificial lift has been gas-lift.

Water encroachment from down dip has already caused the abandonment of several wells. The approach has been very irregular, owing probably to unequal withdrawals and to channels of extreme permeability. No effort has been made to restrict withdrawals of oil and gas to the rate of water approach. This would not be economically feasible as the rate is so slow that the approaching water does not constitute a driving force.

Brief descriptions of the various methods of artificial lift and equipment in use will be given. Apology is made for the lack of tabular data, but the wishes of the operators must be respected in that identity of equipment or methods with companies might mislead the reader as to the operator's producing policy. Despite the widespread use of gas-lift it would be unfair to stamp any of the various

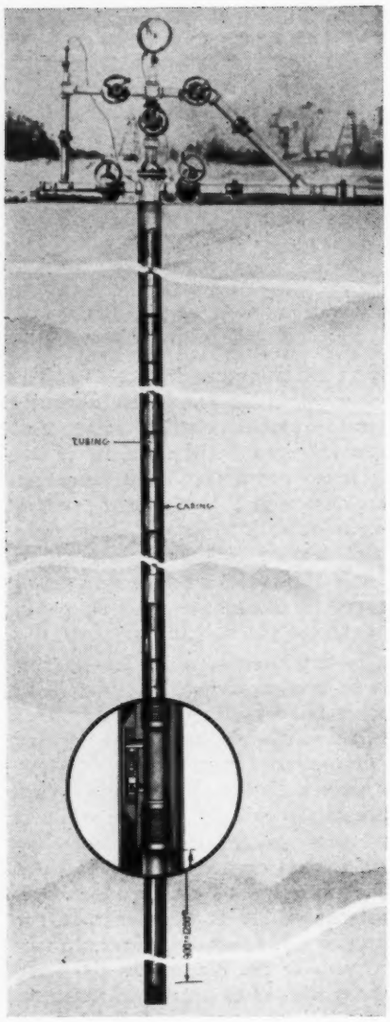


Fig. 1. An open-type installation (without packer) of outside-spring-controlled flow valves

methods as approved or disapproved.

Straight gas-lift consists merely of injecting gas into the casinghead at sufficient pressure to depress the fluid level in the annular space to approximately the depth at which the well is tubed. Gas entering the tubing expands as it rises in the flow column, thereby aerating and lightening the fluid in the flow string. The gas bubbles increase in size and velocity as they rise through the eductor tube. This action continues until the back pressure on the formation due to the weight of the flow column is less than the flowing bottom-hole pressure of the well. By reversing the process, that is, by injecting gas into the tubing, the oil can be produced through the annular space, provided that the productivity of the well is great enough to withstand the increased producing rate.

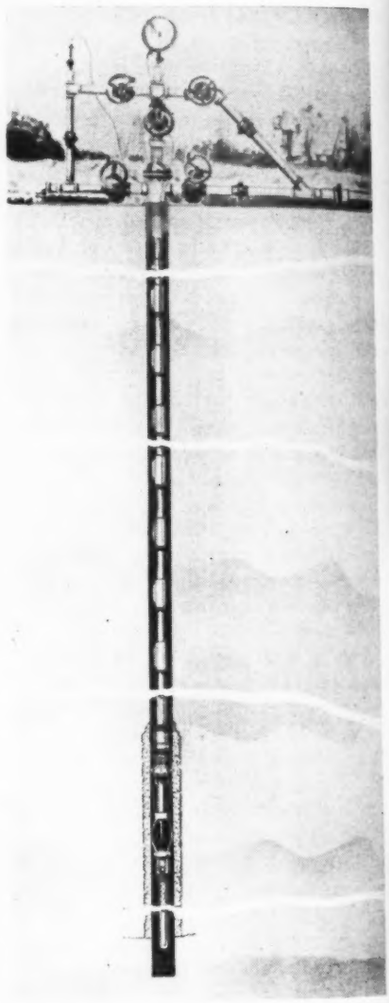
Starting valves or unloading valves have already been mentioned as an aid in inducing flow. This method of starting wells consists of spacing a series of valves, containing gas entry ports, at regular intervals in the tubing string. The opening of these valves is controlled by differential pressure across the valve and the valves are closed when the gas velocity through the valve reaches a set limit. The first valve is usually placed only slightly below the static fluid level in order that the input gas can depress the fluid level in the annular space to the valve, thus admitting gas into the flow string, provided there is enough pressure on the inner side of the valve, by virtue of the weight of the fluid column above it, to reduce the differential pressure across the valve to a value within its opening range. The valve will remain open until the predetermined closing differential pressure is reached, if it is a valve of this type. If of the volocity type, the valve closes when the velocity of gas passing through the valve reaches the closing point. Such valves eliminate the need for high starting pressure and if the valves are properly set the starting pressure need be no greater than the operating pressure. The valve, once it has accomplished the purpose for which it is intended, remains closed, and casing and tubing pressures must be equalized to reopen it. The behavior of the system then approaches straight gas-lift, that is, gas is injected at the bottom of the flow string.

Manufacturers of gas-lift equipment have offered flow valves of many types to the producer. For previously stated reasons, and because the operation of flow valves cannot be fully described without disclosing their identity, the principle of only the outside-spring-controlled type will be reviewed, as this is the predominant differential flow valve used in the Rodessa field.

The purpose of this type valve is to induce intermittent flow by introducing gas into the tubing string at intervals. (Fig. 1.) Each valve must have sufficient capacity to flow the well, as the selection of the operating valve depends upon well characteristics in addition to input pressure and valve setting. As in the previously mentioned starting valves, the opening and closing methods are the same; i.e., pressure differential for opening and gas velocity through the valve or pressure differential for closing. Several variables enter into the computations to determine the setting of the valves. Among these are valve-stem clearance, area and travel, spring tension, and port size. By virtue of these variable elements, settings to suit many conditions can be made.

Under optimum conditions flow-valve operation will result in greatly reduced input gas/oil ratios as compared to straight gas-lift, because the fluid is lifted by slugs or piston-type flow rather than by aeration of the entire column. Leakage through the valves, however, would cause large gas losses, intervalve interference, and paraffin deposition. When reservoir pressure declines below the pressure required to lift the fluid, very efficient lift has been obtained by use of a packer on the flow-valve-equipped string (Fig. 2) and a check valve in the tubing at the packer. The induced gas pressure maintains the valves in a closed position until a fluid column of sufficient height to establish a predetermined opening load on the lower or operating valve has accumulated. Thus the productivity of the well governs the frequency of the flow cycle. This

Fig. 2. A closed system of outside-spring-controlled flow valves



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Lufkin's TC-55-7A for Shallow Production, Polish Rod Capacity 10,000 pounds, Stroke 22", 32" and 42", Weight Complete 11,660 Pounds.

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The Greatest Value in Lufkin's History is the new **Lufkin TC-55-7A Unit Assembly**—an economical and substantial unit for shallow production.

This unit, designed after the fashion of the larger LUFKIN units, is made of the same quality materials in every detail and is given the same degree of inspection for fine workmanship.

A modified Trout Conterbalance Crank is a part of the new assembly with the advantages of sliding weights which has made the LUFKIN Crank a leader.

The complete assembly includes wire line hanger, counterweights, slide rails, belt cover, belts and motor sheave, and the base is furnished for any type prime mover.

LUFKIN PUMPING UNITS

LUFKIN UNITS are manufactured in Lufkin, Texas, by the Lufkin Foundry & Machine Company. Branches in principal oil centers

system, however, is adaptable only to wells of maximum daily capacities of 140 to 175 bbl., as the time required for loading the flow string and exhausting the gas used in lifting is considerable in wells equipped with 2½-in. tubing. (Fig. 3.)

Intermittent Flow Chamber Operation

The intermittent flow chamber type of gas-lift has been known to the industry for many years and several improvements have been made in its operation, the combination of the chamber displacement method with casing flow being one of the most recent.

At the present time all such units in Rodessa are operating on the east side of the field, the area to suffer first from water encroachment. This is a narrow belt directly between the gas cap paralleling the fault line and the original oil-water contact. Because of this structural position, relatively high fluid levels have been maintained, an essential adjunct to economic operation of this unit.

This device consists of a flow chamber 5 in. in diameter, containing a standing valve in the bottom, and a 2-in. discharge line extending from the top of the flow chamber to a point within a few feet of the standing valve. The length of the flow chamber can be varied to suit operating conditions but is usually 100 to 120 ft. It is connected to the 2-in. or 2½-in. tubing through a 7-in. hookwall packer. The 2-in. discharge line in the chamber contains a check valve at its connection to the packer and this connection is open to the annular space. A surface intermitter admits high-pressure gas through the tubing into the flow chamber, thus displacing the fluid in the flow chamber downward, then upward through the discharge line to the annular space. The expansion of the displacing charge of gas provides the energy to lift to the surface the fluid transferred into the casing.

As pressure is applied to the surface of the fluid in the chamber, the standing valve is closed and remains closed until the gas required to lift the accumulated fluid has accomplished its purpose. The check valve in the discharge line prevents any fluid that might be bypassed during flow from returning to the flow chamber from the annular space. In setting the unit, it is best to submerge it just below the flowing fluid level of the well. Submergence will vary directly with available operating pressure. Available pressure and the fill-up rate of the well govern the frequency of the flow cycle. The value of the unit in lifting large volumes of fluid from wells capable of submerging the unit has been demonstrated in this field throughout the last two years.

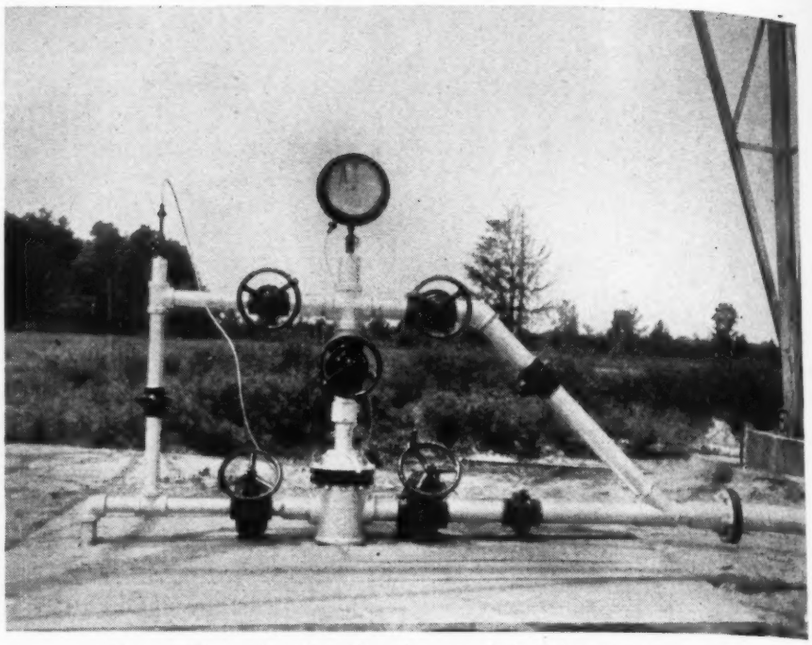

Fig. 3. Streamlined wellhead on gas-lift well in Rodessa field

Plunger-Lift

The plunger-lift method of lifting oil will be included with other forms of gas-lift as the energy is provided by gas, although the oil is lifted by a plunger. The plunger travels the entire distance from the bottom to the top of the tubing and back again at each stroke. The equipment includes a string of special smooth-bore tubing supported from the flowhead at the surface. This head is designed to receive the slug of oil lifted by the plunger and to equalize pressures, thereby allowing the plunger to fall to bottom. A foot-piece at the bottom of the tubing stops the downward travel of the plunger and closes the valve in the plunger at the end of the downstroke. The plunger itself fits rather loosely in the tubing and, after having been lifted by the gas, falls by gravity to the bottom of the tubing. While the plunger is falling, the pressure in the tubing declines and gas from the casing and fluid from the well enter the tubing and accumulate for the next load. Inasmuch as the casing gas bleeds slightly while the liquid load is entering the tubing, a small amount of gas is wasted through the falling plunger, as the plunger valve is open when falling.

Although small production can be lifted economically by this method, the productivity of the unit, like other forms of gas-lift, is dependent upon submergence. Therefore, the productivity and operating-pressure decline of any one size plunger will parallel the decline in reservoir pressure.

Ordinarily this would indicate the plunger-lift to be incapable of depleting the reservoir under conditions of extreme pressure decline. Most wells in which the plunger-lift has been installed in Rodessa, however, have been producing from a gas-drive reservoir wherein production has declined directly with the reservoir pressure, and evidence at present indicates that economic depletion of the reservoir will be reached before the gas drive is completely exhausted.

Production from such a well, after natural flow ceases, does not justify any considerable expense for equipment, owing to the low productivity and probable short life of the artificial-lift period.

This equipment has been installed in other wells in and near the water-producing area of the field where it is thought that the total volume of fluid to be produced will not exceed the capacity of the 2½-in. unit. Where large volumes of fluid must be produced, larger units of greater capacity will probably be installed.

EDITOR'S NOTE: This discussion will be concluded in an early issue.

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A Comparison of Rotary, Beam, and Pneumatic Counterbalances

Part I

A PETROLEUM ENGINEER FEATURE

A study of the effectiveness, adjustability, and sensitiveness of the different counterbalances

By KENNETH N. MILLS

Chief Engineer, American Manufacturing Company of Texas

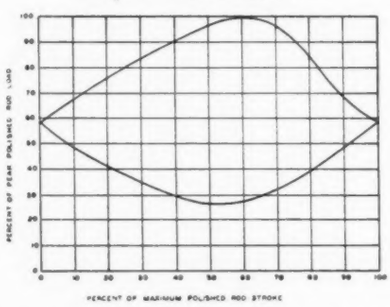
FUNDAMENTALLY, the purpose of a counterbalance on an oil-well pumping machine is to decrease the magnitude of the peak load imposed on the driving mechanism. All types of counterbalances accomplish this purpose by absorbing energy when the power demand imposed on the driving mechanism is low, and releasing this energy when the power demand is high. Although counterbalances of all types operate on this one basic principle, their effects on the characteristics and magnitude of the loads imposed on the driving mechanism are widely different.

As the fundamental purpose of any counterbalance is to decrease the peak load imposed on the driving mechanism, its effectiveness in accomplishing this purpose is the first measure of its efficiency, but it must achieve this aim with equal effectiveness at all practical operating speeds. The characteristic effects of a given type counterbalance on the net torque load imposed on the driving mechanism can be illustrated by plotting crankshaft torque curves for a pumping machine using the type of counterbalance under consideration. In preparing this curve it is necessary to assume that the crankshaft rotates at a constant speed, that a specific amount of effective counterbalance is required, and that the connected load has specific characteristics.

The character of the connected load used in this investigation is shown in Fig. 1. This average dynamometer card was obtained by averaging about 35 selected dynamometer cards taken on typical wells. It was assumed that a static counterbalance effect equal to 60 percent of the peak well load was desirable, and, in the case of the beam balance, the weight was placed at the centerline of the beam pitman bearing. The same type rig geometry was used to analyze each type counterbalance. The geometry of the rig used is defined in Fig. 2.

The well, counterbalance, and net torque curves obtained under these conditions when operating at a crankshaft speed of 20 r.p.m. using rotary, beam, and pneumatic counterbalances are shown in Figs. 3, 4, and 5, respectively. The curves for beam and pneumatic counterbalance indicate that, for the type of rig geometry considered, too great counterbalance weight was used, as the net peak torques on the two halves of the pumping cycle are not equal. If the amount of counterbalance used had been such that these two peaks were equal, the net torque curves for these two condition would have been virtually the same. Therefore, it follows that each type of counterbalance under consideration will accomplish its mission effectively at this speed.

Fig. 1. Typical polished rod dynamometer card



Assuming operation at constant speed, the amount of counterbalance effect created by the rotary and pneumatic types of counterbalance is independent of the operating speed. This is not true of the beam balance, because changes in operating speed will affect the rate at which it is accelerated and decelerated, and this change in its rate of acceleration and deceleration will change the magnitude and

KENNETH N. MILLS

received a B.S. degree in mechanical engineering from Rice Institute, Houston, Texas, in 1933—He joined the engineering staff of he American Manufacturing Company of Texas, Fort Worth, in 1934 and was placed in charge of that department in 1935 — During his association with the petroleum industry he has devoted considerable time to the analytical study of problems encountered in oil-well pumping.

character of its force. The effective weight of a beam counterweight is expressed by the following equation:

$$W_e = W \pm \frac{W}{g} a \qquad (1)$$

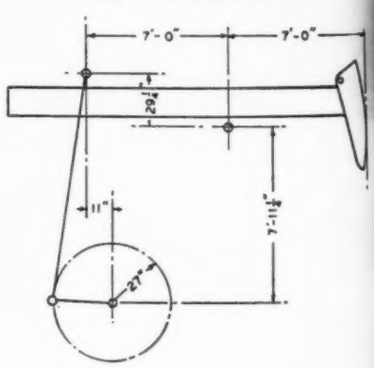
Where

W_e = Effective weight, lb.
W = Weight of body being accelerated, lb.
g = Acceleration of gravity (32.2 ft. per sec. per sec.)
a = Vertical acceleration, ft. per sec. per sec.

From this equation it can be seen

(Continued on Page 46)

Fig. 2. Rig geometry



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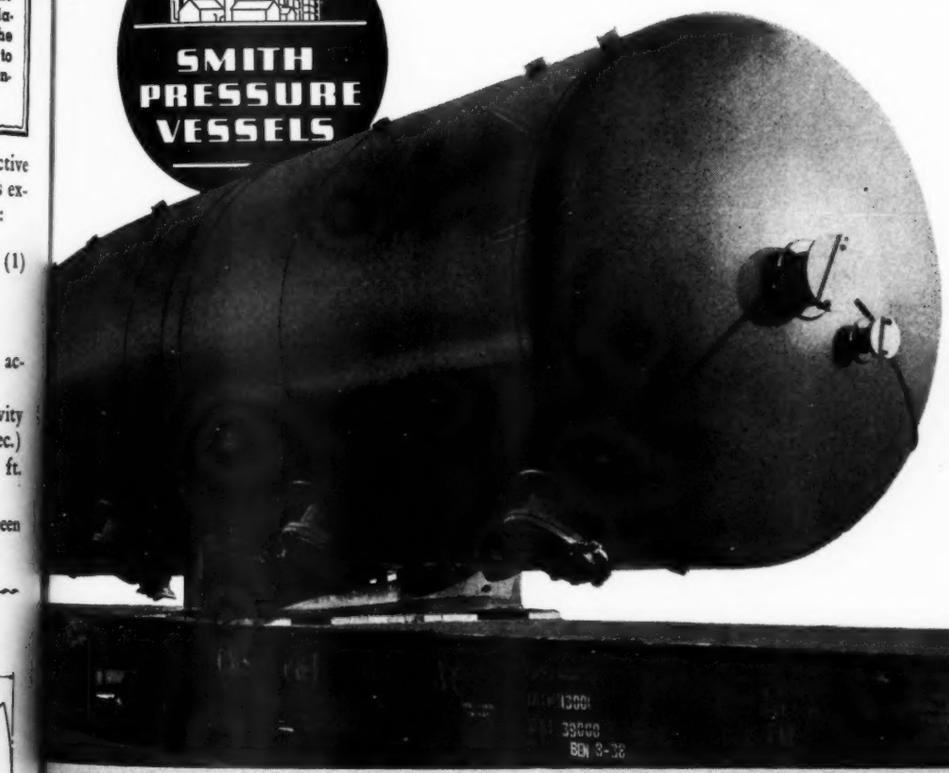

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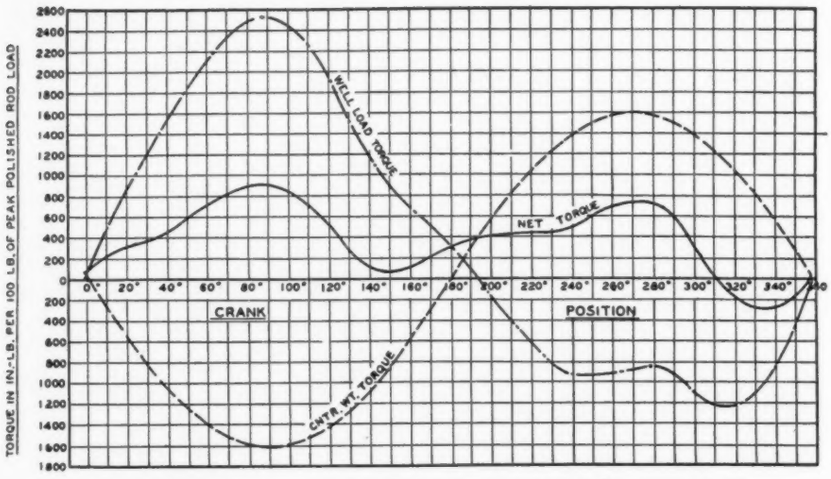


Fig. 3. Torque curve, rotary balance, counterclockwise rotation

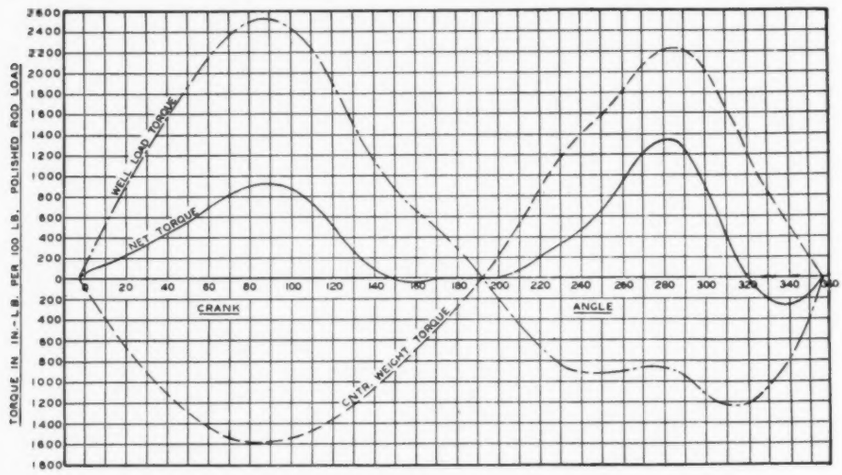


Fig. 4. Torque curve, beam balance, counterclockwise rotation

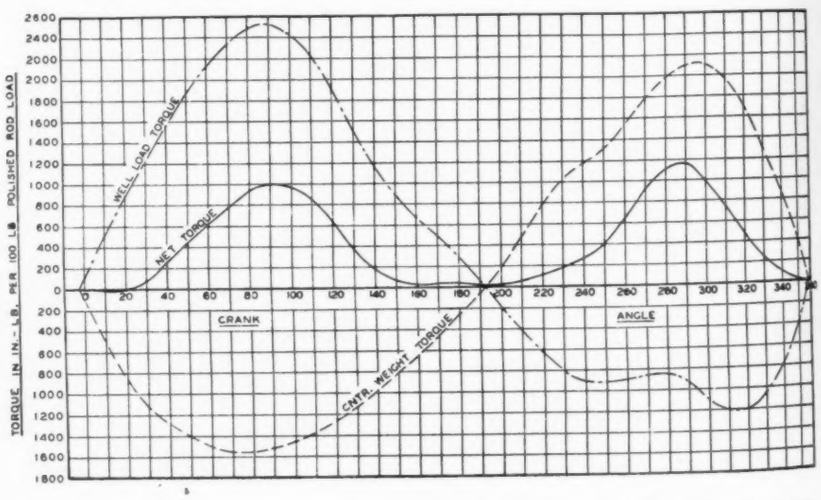
(Continued from Page 42)

that the effective counterbalance force created by a beam balance will vary, and its magnitude will depend on its rate of acceleration at the instant under consideration.

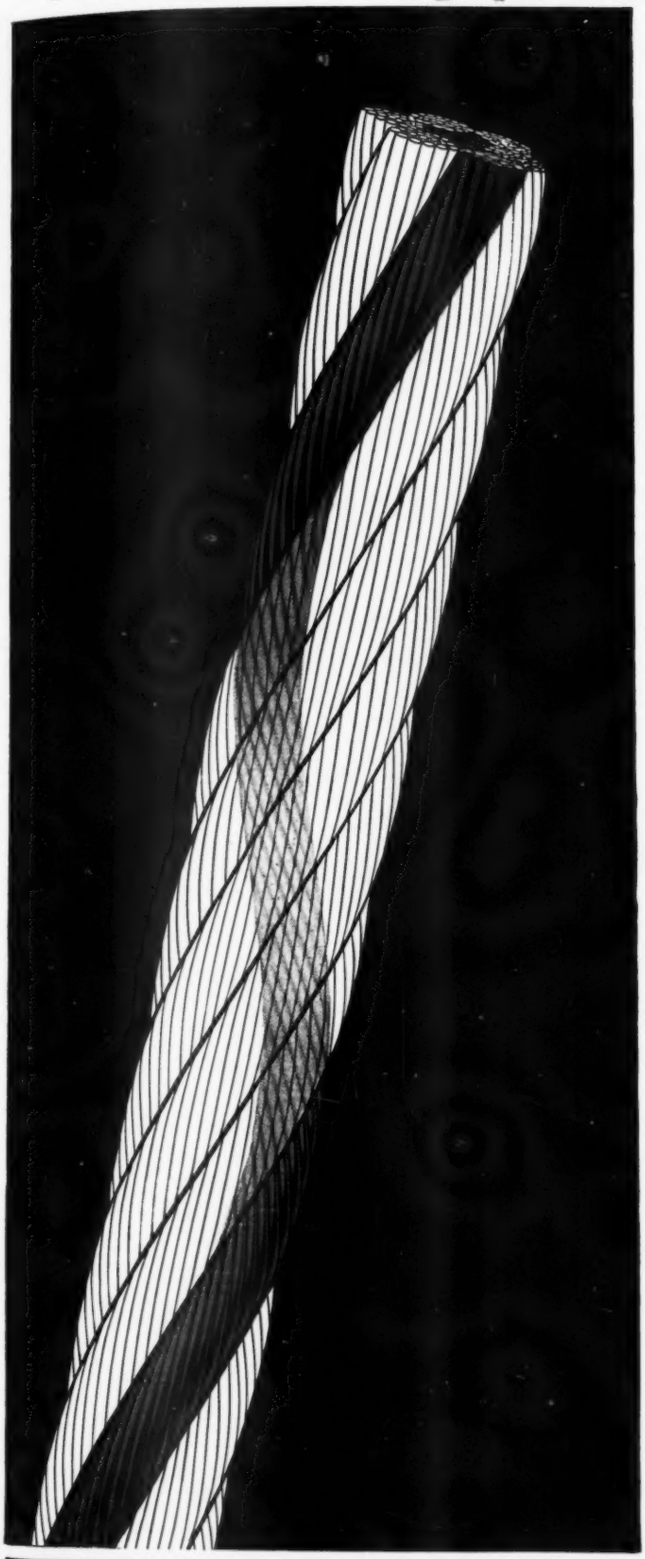
An acceleration-and-velocity curve for the motion of the polished-rod on the pumping machine under consideration, when its driving mechanism is rotating at a constant speed of 20 r.p.m., is shown in Fig. 6. As the rate of the polished-rod acceleration is proportional to the square of the crankshaft speed, the counterbalance torque created by a given beam balance will vary with the operating speed. The torque characteristics of the beam balance used in this investigation when operating at various crankshaft speeds are shown in Fig. 7. Examination of these curves reveals that increasing the operating speed of a beam balance increases slightly the amount of counterbalance torque created by it, and slightly shifts the angular location of its peak torque. If the counterbalance effect were reduced to its original value by decreasing the counterbalance weight, the only effect of increased operating speed on the counterbalance torque curve would be an angular shift in the location of the peak torque. Owing to changes in the characteristics of the well load as the pumping speed is varied, this change is unimportant.

Beam counterbalance was abandoned by most operators several years ago, because of numerous beam failures experienced on pumping machines using beam balance. These failures, no doubt, were caused by poorly constructed beam balances, because if the beam balance is properly constructed there is no adverse bending in the beam, even when the acceleration of the beam weight exceeds that of gravity. Fig. 8 is the bending-moment diagram for the beam of a unit equipped with rotary counterbalance when loaded as shown in the loading diagram. In this case, the maximum bending moment is imposed on the beam at the saddle and is equal to the well load multiplied by the distance from the well to the saddle. Fig. 9 is a bending-moment diagram for the beam of a unit using beam balance and being operated at a speed that does not cause the effective force created by the beam weight to become negative. In this case, the maximum bending moment is imposed on the beam at the beam saddle, and its magnitude is the same as in the case of the rotary counterbalance. Fig. 10 is a bending-moment diagram for the beam on a unit equipped with beam counterbalance but being operated at a speed that will cause the effective

Fig. 5. Torque curve, air balance, counterclockwise rotation



PURPLE-STRAND *FORM-SET* ROTARY LINE



Here's what *FORM-SET* means

IN WIRE ROPE, individual wires and strands form a helical or screw pattern in the complete rope. Ordinarily these individual wires and strands are straight before entering the stranding and closing dies. They are forced into this helical shape and held there by seizing at the end of the rope. Remove this seizing, and strands fly apart from internal pressures.

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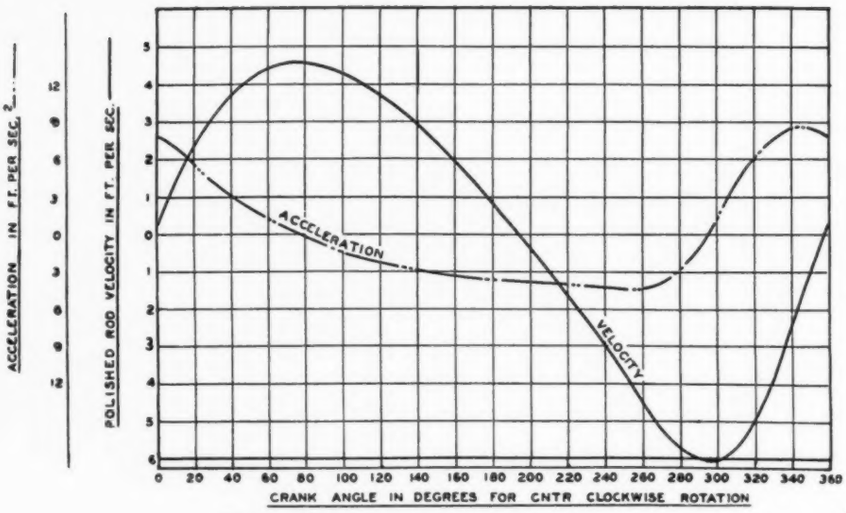

ACCELERATION IN FT. PER SEC.²
POLISHED ROD VELOCITY IN FT. PER SEC.
ACCELERATION
VELOCITY
CRANK ANGLE IN DEGREES FOR CNTR CLOCKWISE ROTATION

Fig. 6. Velocity and acceleration curve

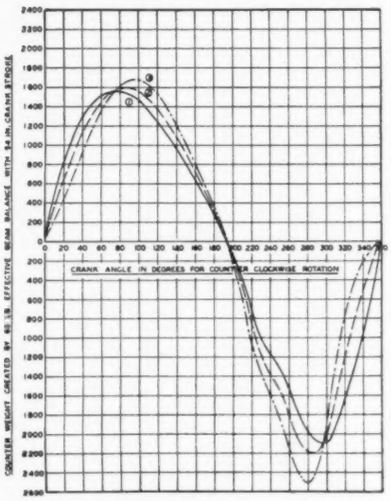


Fig. 7. Beam balance torque curve. Legend: (1) very slow speed. (2) 20 s.p.m. (3) 30 s.p.m.

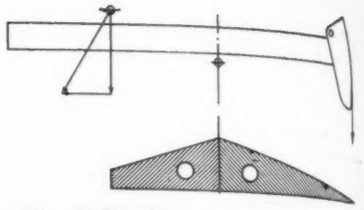


Fig. 8. Bending moment diagram with rotary balance

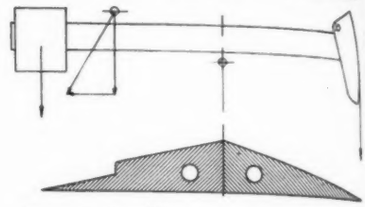


Fig. 9. Bending moment diagram with beam balance at low speed

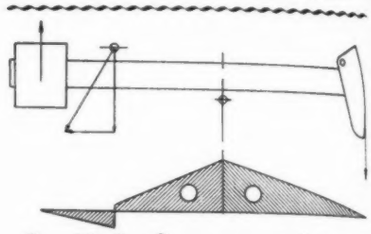


Fig. 10. Bending moment diagram with beam balance at high speed

any adverse bending stress in the beam and the acceleration of the weights will be reduced, as the rate of acceleration at any point on the beam is proportional to the distance of that point from the beam pivot point.

All these statements are predicated

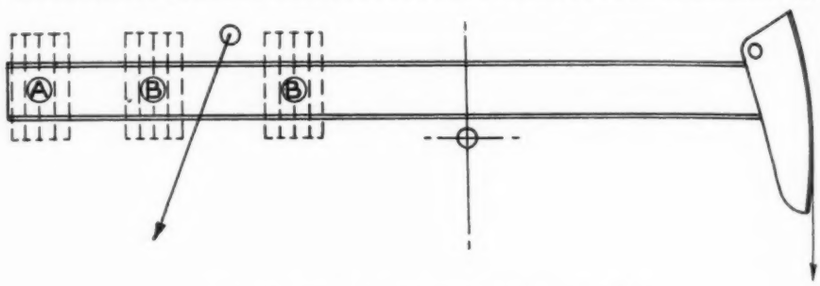
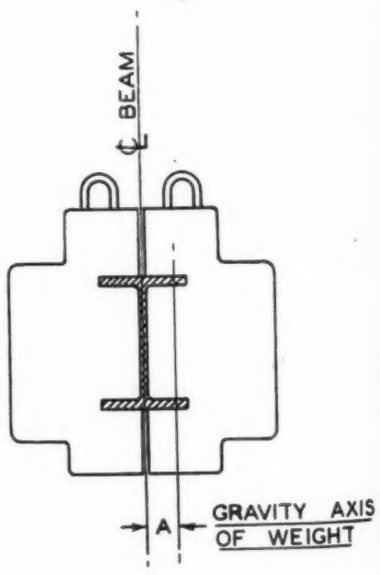


Fig. 11. Possible locations for beam weights

force of the weight to become negative. In this case, unless the upward force of the weight is extremely great, the location and magnitude of the maximum bending moment will be the same as before.

In each of the beam layouts discussed, the beam weights have been placed back of the beam pitman bearing as shown by the weight location A in Fig. 11. This is not the optimun location but it is the most common, as less counterweight material is required. If the weights are placed as shown by location B in Fig. 11 (that is, their center of gravity coincident with the center of the pitman bearing) the beam weight will not produce on a properly constructed beam weight. If the center of gravity is not coincident with the vertical centerline of the beam, torsional stresses will be developed in the beam. From Fig. 12 it can be seen that, if the center of gravity of the weight lies at a distance A from the vertical centerline of the beam, a torsional moment equal to A times the maximum effective weight of the counterweight will be imposed on the beam. The stress in the beam will add to that produced by the normal bending moment imposed on the beam, and the combination can cause beam failure.

Fig. 12



EDITOR'S NOTE: This discussion will be concluded in a future issue.

THE *Petroleum* Engineer's CONTINUOUS TABLES

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INSTALLMENT No. 23

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Gilmore Wire Rope Division of Janes & Laughlin Steel Corporation		62	Mar.	P 425.215
Hanlon-Buchanan, Inc.		248	Oct.	P 771.214.750
Hanlon-Buchanan, Inc.		82	Feb.	P 771.214.740
Harrisburg Steel Company		56	Apr.	P 721.010.09
Hyatt Bearings Division, General Motors Corporation		126	Sept.	P 553.300.125
Hyatt Bearings Division, General Motors Corporation		58	Mar.	P 444.1
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International Harvester Company	(sheet 2)	114	Aug.	P 644.200.1
Larkin Packer Company	(sheet 2)	62	Apr.	P 538.066
Layne & Bowler Company		118	Aug.	P 533.300.15
Linde Air Products Company		110	Aug.	P 615.110.30
Linde Air Products Company	(sheet A)	246	Oct.	P 621.100.1
Lunkenheimer Company	(sheet 2)	120	Sept.	P 725.113.2
Lunkenheimer Company		74	Jan.	P 771.214.745
Lunkenheimer Company		64	Mar.	P 094.818.11
Lunkenheimer Company	(sheet 2)	64	Apr.	P 094.111.2
MacClatchie Manufacturing Co.	(sheet 4)	72	Jan.	P 448.430
Macwhyte Company		112	Aug.	P 425.240.662
Merla Tool Company	(sheet 2)	88	Feb.	P 515.5
Mission Manufacturing Company	(sheet 3)	84	July	P 094.865.1
Patterson-Ballagh Corporation	(sheet 2)	80	Jan.	P 448.456
Petroleum Rectifying Company	(sheet 1)	132	June	P 515.5
Petroleum Rectifying Company		76	Jan.	P 771.214.755
Reed Roller Bit Company		124	June	P 425.240.450
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South Chester Tube Company	(sheet 1)	132	Sept.	P 448.430
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Spang & Company		108	Aug.	P 424.22
Staynew Filter Corporation		126	June	P 615.108.30
Staynew Filter Corporation		250	Oct.	P 066.000
Thermoid Company		128	Sept.	P 425.240.237
Westinghouse Electric & Mfg. Company		134	June	P 094.14
Westinghouse Electric & Mfg. Company		130	Sept.	P 094.839
Westinghouse Electric & Mfg. Company	(sheet 2)	146	Nov.	P 094.603.1

A Decimal System for Classifying Data Pertaining to the Petroleum Industry

Part 5

By LESTER C. UREN

Professor of Petroleum Engineering, University of California, Berkeley, California

700 to 799. Oil Refineries and Refinery Practice (continued)

770. Condensation of vapors from hydrocarbon gases.
771. Theoretical considerations: physical and chemical properties of hydrocarbon vapors and gases. (See also under 210, 220, and 262.)
.1 Testing natural gases and refinery gases for condensable-vapor content.
.11 Charcoal adsorption method.
.12 Oil absorption method.
.13 Compression and refrigeration method.
.14 Selective condensation method.
.2 Retrograde condensation of hydrocarbon vapors in production from deep-seated reservoir rocks.
772. Compression and refrigeration process for extraction of natural gasoline from gas.
.1 Plant lay-out and design.
.2 Plant construction.
.3 Compression of gas.
.31 Gas compressors.
.32 Power development for gas compression.
.321 Gas-engine-driven compressors.
.322 Steam plant for gas compression.
.4 Cooling compressed gas.
.41 By compressor inter-coolers and after-coolers.
.42 By louvre towers.
.421 Using air-cooled coils.
.422 Using water sprays.
.43 By cooling ponds.
.44 By expansion of gas.
.441 In pipe expansion coils and heat exchangers.
.442 In expansion engines.
.45 By use of liquid ammonia cooling systems.
.5 Gas receiving, piping, and discharge systems.
.51 Gas-receiving traps and scrubbers.
.52 Low-pressure gas piping.
.53 High-pressure gas piping.
.54 Gas discharge traps.
.6 Condensate-collecting systems.
.61 Accumulator tanks.
.62 Condensate piping.
.7 Plant operation and control.
.9 Other data on the compression and refrigeration process.
773. Oil absorption process for extraction of natural gasoline from natural gas.
.1 Absorption-plant lay-out and design.
.2 Plant construction.
.3 Absorbing oils and their properties.
.35 Deterioration and reconditioning of absorber oils.
.4 Types of absorbers and details of construction.
.41 Low-pressure absorbers.
.42 High-pressure absorbers.
.43 Baffling material for use in absorption towers.
.44 Bubble towers.
.5 Oil circulating system.
.51 Oil storage tanks.
.52 Oil pumps.
.53 Oil cooling systems.
.54 Oil piping.
.55 Oil traps.
.6 Distillation methods and equipment.
.61 Types of stills. (See also under 734.)
.611 Steam stills and steam generating equipment.
.62 Heat exchangers.
.63 Condensers.
.64 Traps.
.7 Absorption-plant operation and control.
.8 Stabilizer operation and control.
.9 Other data on the oil absorption process.
774. Adsorption process for extraction of natural gasoline from natural gas.
.1 Adsorption media.
.11 Charcoal.
.12 Silica gel.
.2 Adsorption-plant lay-out and design.
.3 Adsorption-plant construction.
.4 Adsorption towers.
.5 Retorting or distilling equipment for adsorption process.
.6 Adsorption-plant operation and control.
.9 Other data on adsorption processes.
775. Extraction of gasoline and other light condensates from natural gas (in general). (See also under 772 and 773.)
.1 Recovery of butane-propane mixtures.
.2 Retrograde condensation of hydrocarbon vapors.
776. Extraction of helium from hydrocarbon gases. (See also under 772.)
.1 Helium content of natural gases; methods of analysis.
.2 The Linde process of helium extraction.
.3 The Claude process of helium extraction.
777. Extraction of toluol, benzene and benzol, and other by-products from natural gas.
.1 Production of hydrogen from natural gas.
.2 Extraction of carbon dioxide and "dry ice" from natural gas.
778. Weathering, blending, stabilizing, storing, and shipping of light condensates.
.1 Weathering of light condensates.
.2 Stabilizing of light condensates.
.3 Blending of light condensates with heavier distillates.
.4 Storage of natural gasoline and other high-vapor-pressure condensates. (See also under 640.)
.5 Shipping and transportation of natural gasoline and other high-vapor-pressure condensates. (See also under 615.92 and 613.)
.51 Shipping regulations for rail transportation.
.52 Shipping containers for high-vapor-pressure products.
779. Other data on condensation of vapors from hydrocarbon gases.
780. Manufacture of carbon black from natural gas.
781. Theoretical considerations underlying formation of carbon black.
.1 Testing for ethane content as a measure of carbon black value of natural gas.
782. Contact flame processes for carbon black manufacture.
.1 The Channel process.
.2 Small rotating disc process.
.3 Roller or rotating cylinder process.
.4 Large horizontal plate process (Cabot process).
.5 Types of gas burners for carbon black manufacture.
.6 Gas pressure and air-supply control devices.
783. Formation of carbon black by incomplete combustion of gas resulting from inadequate air supply.
784. Formation of carbon black by "cracking" of hydrocarbon gases and vapors.
785. Lay-out and design of carbon black plants.
786. Construction of carbon black plants.
787. Operation and control of carbon black plants.
788. Collecting, packing, and shipping of carbon black.
789. Other data on manufacture of carbon black from natural gas.
790. Other data on refining of petroleum and related products.
791. Corrosion in refinery equipment and methods of minimizing destruction due to corrosion.
.1 Use of chromium and other corrosion-resisting metals.
.2 Electrolytic corrosion.
.21 Cathodic protection.

EDITOR'S NOTE: This is Part 5 of a series presenting a complete classification of petroleum technology, useful to those interested in a ready-made system for filing data concerning the petroleum and related industries. Earlier installments have appeared in the November, 1938, and January, February, March and April, 1939, issues of *The Petroleum Engineer*.

The Petroleum Engineer is indebted to the publishers of *National Petroleum News*, owners of the copyright on the 1928 edition of the Classification, for permission to publish this expanded and modernized edition.

800 to 899. Utilization of Petroleum and Its Products

800. General reference, text, and hand books on utilization of petroleum and its products.
801. Utilization of naphthas: benzine, gasoline, and engine distillates.
802. Utilization of kerosene and related illuminating and burning oils.
803. Utilization of lubricating oils and greases.
804. Utilization of fuel oil.
805. Utilization of asphalt and related products.
806. Utilization of paraffin and related products.
807. Utilization of hydrocarbon gases.
808. Utilization of petroleum coke.
809. Utilization of miscellaneous other petroleum products.
.1 Utilization of petrolatum and medicinal oil products.
810. Utilization of petroleum and related products in developing heat and power.
811. Burners and burner appliances.
.1 For liquid fuel.
.11 Oil pumps.
.12 Oil heaters.
.13 Fuel oil piping.
.14 Control valves.
.15 Fuel oil burners.
.151 Steam atomizing.
.152 Air atomizing.
.153 Mechanical atomizing.
.2 For gaseous fuel.
.21 High-pressure burners.
.22 Low-pressure burners.
.23 Gas pressure regulators.
812. Steam raising.
.1 With oil fuel.
.2 With gaseous fuel.
813. Industrial furnace heating.
.1 With oil fuel.
.11 With fuel oil.
.12 With gasoline and related products.
.2 With gaseous fuel.
814. Domestic heating.
.1 With fuel oil and heavy distillates.
.2 With hydrocarbon gases.
.21 With natural gas.
.22 With manufactured gas.
.23 With light distillate and condensate vapors.
.3 With kerosene and related distillates burned in oil stoves and heaters.
4. With paraffin stoves.
815. Power development with internal combustion engines of explosive type, using light distillate (kerosene and naphtha) as fuel.
.1 Two-cycle engines.
.2 Four-cycle engines.
.3 Carburetors.
.4 Ignition systems.
.5 Fuel "dopes" and anti-knock compounds.
816. Power development with internal combustion engines of explosive type, using hydrocarbon gas as fuel. (Subdivide as under 815.)
817. Power development with Diesel and semi-Diesel types of oil engines.
.1 Two-cycle engines.
.2 Four-cycle engines.
.3 Ignition systems.
.4 Air compression equipment.
.5 Starting equipment.
818. Development of heat and power through the burning of solid hydrocarbons.
.1 Oil shale.
.2 Oil coke.
819. Other methods of developing heat and power from petroleum and related products.
.1 By burning acid sludge.
.2 Development of power through application of the expansive force of high-pressure natural gas.
820. Utilization of petroleum products in developing light.
821. Utilization of natural gas in illumination.
822. Utilization or manufactured oil gas in illumination.
823. Utilization of acetylene generated from carbides in illumination.
824. Utilization of compressed or liquefied gas in illumination.
825. Utilization of gasoline and other light distillate vapors with incandescent mantles.
826. Use of kerosene and related distillates in lamps and wicks.
827. Use of paraffin candles and paraffin lamps.
829. Other data on use of petroleum and related products in developing light.
830. Utilization of petroleum products for lubrication and similar purposes.
.1 Theory and principles of lubrication.
.2 Lubrication devices and appliances.
.3 Lubrication systems.
831. Lubrication of steam cylinders and turbines.
832. Lubrication of internal combustion engine cylinders.
833. Lubrication of compressor and vacuum pump cylinders.
834. Lubrication of ice machines and other low-temperature devices.
835. Lubrication of journals, bearings, glands, and spindles.
.1 High-speed machines.
.2 Heavy, slow-speed machines.
836. Lubrication of gears, sprockets, and pinions.
837. Lubrication of screw threads, cutting dies and taps, lathe cutting tools, twist drills, etc.
838. Recovery and rejuvenation of spent lubricating oils.
.1 By centrifugal treatment.
.2 By filtration.
.3 By distillation.
839. Lubrication of other mechanisms; other data on lubrication.
840. Structural uses of petroleum and petroleum products.
841. Use of petroleum products in paving and road surfacing.
.1 Sheet asphalt paving.
.2 Asphalt cement paving.
.3 Asphalt block paving.
.4 Brick-asphalt paving.
.5 Use of hot molten asphalt as binder for loose surface material.
.6 Use of road oils in laying dust and compacting loose surface material.
842. Use of petroleum products in waterproofing.
.1 Conduits and tunnels.
.2 Retaining walls.
.3 Canals.
.4 Levees.
.5 Pipe lines.
.6 Tanks and other receptacles.
.7 Roof joints, skylights, etc.
843. Use of petroleum products in manufacture of roofing and building materials.
.1 Roofing paper.
.2 Sound deadening material.
.3 Building paper.
.4 Heat insulating material.
844. Use of petroleum products in paint manufacture.
.1 Paraffin and asphaltic paints and enamels, varnishes and lacquers.
.2 Turpentine substitutes for use in paints.
849. Other structural uses.
850. Use of petroleum products in hydrocarbon gas manufacture.
851. Oil gas manufacture.
852. Use of oil for enrichment of coal gas.
853. Water gas manufacture.
854. Pintsch gas manufacture.
855. Producer gas manufacture, using oil shale as fuel.
859. Other data on use of petroleum and related products in gas manufacture.
860. Medicinal and pharmaceutical uses of petroleum and related products.
861. Use of petroleum products in emolients.
862. Use of petroleum products in manufacture of medicinal oil laxatives.
863. Use of petroleum products in manufacture of ethers and other anesthetics.
864. Use of petroleum products in manufacture of insecticides.
869. Other medicinal and pharmaceutical uses of petroleum products.
870. Metallurgical and chemical uses of petroleum and related products.
871. Flotation oils.
872. Use of hydrocarbon gases to effect reducing action.
.1 On iron oxides in iron and steel manufacture.
873. Use of fuel oil and hydrocarbon gases as metallurgical furnace fuel. (See also under 813.)
874. Use of oils as quenching agents in heat treatment of metals.
875. Use of asphalt in electro-plating.

876. Use of paraffin in manufacture of containers for corrosive chemicals.
877. Use of petroleum products in manufacture of various chemicals, reagents, and derivatives.
.1 Production of hydrogen from methane; production of ammonia and fertilizer.
.2 Production of alcohols.
.3 Production of methyl chloride and dichloride.
.4 Production of chloroform.
.5 Production of carbon tetrachloride.
.6 Production of formaldehyde.
.7 Production of acetone.
879. Other metallurgical and chemical uses for petroleum and related hydrocarbons.
880. Use of petroleum and petroleum products in soap manufacture; as cleansing agents, and as solvents.
881. Use in manufacture of naphtha soaps.
882. Use of benzine and gasoline in dry cleaning.
883. Use of light naphthas as solvents.
.1 In rubber manufacture.
.2 For dissolving various solid hydrocarbons.
890. Miscellaneous other uses for petroleum, petroleum products, and related hydrocarbons.
891. Electrical uses.
.1 As transformer oil.
.2 As switch oil.
.3 Use of petroleum coke in manufacture of electric arc-light carbons.
.4 Use as insulating material in wire coverings.
892. Use in rubber manufacture.
.1 As rubber substitute.
.2 Use of carbon black as rubber "filler."
893. Use in dye and ink manufacture.
.1 Use of petroleum products as a source of dye stuffs.
.2 Use of carbon black in manufacture of printers' inks.
894. Use of petroleum products in explosives manufacture.
.1 As a source of toluene.
895. Use of petroleum products in textile industries.
896. Use of greases and oils in preventing corrosion of iron and steel.
897. Use of petroleum products as preservatives.
.1 Of timber.
.2 Of fruits, vegetables, flowers, etc.
898. Use of paraffin in match manufacture.
899. Miscellaneous other uses of petroleum and petroleum products.
.1 Use of paraffin in recovery of diamonds.
.2 Use of paraffin in water-proofing liquid containers.

900 to 999. Economics of the Petroleum and Related Industries

900. General reference, text, and hand books on economics of the petroleum and related industries.
901. Economics of the petroleum producing industry.
902. Economics of the petroleum transportation industry.
903. Economics of the petroleum refining industry.
904. Economics of the natural gas industry.
905. Economics and commercial aspects of the shale oil industry. (See also under 503. and 584.)
906. Economics of the natural asphalt industry.
907. Economics of the mineral wax industry.
910. Statistics of the petroleum industry and regional economics.
911. General regional statistics of the petroleum industry. (Subdivided as under 100.; thus, for general petroleum industry statistics of the United States, use the number 911.11, and for California, 911.116.1. The geographical index as outlined under 100. may also be used in further elaboration of numbers 912. to 918. below.)
912. Crude petroleum statistics.
.1 Crude petroleum production statistics.
.11 Petroleum production statistics.
.12 Well statistics.
.13 Acreage statistics.
.14 Land ownership and control statistics.
.15 Statistics of labor employed in the petroleum producing industry.
.16 Capital invested in the petroleum producing industry.
.17 Statistics of operating companies in the petroleum producing industry.
.18 Statistics of producing properties.
.2 Crude petroleum consumption statistics.
.3 Crude petroleum pipe-line transportation statistics.
.4 Crude petroleum storage statistics.
.5 Crude petroleum price statistics.
.6 Crude petroleum United States export statistics.
.7 Crude petroleum United States import statistics.
913. Statistics of the petroleum refining industry.
.1 Statistics of crude petroleum run to stills.
.2 Statistics of labor employed in the refining industry.
.3 Statistics of capital invested in the refining industry.
.4 Statistics of operating refineries.
.5 Statistics of operating refining companies.
914. Statistics of refined petroleum products.[19]
.1 Gasoline and engine distillate statistics.
.11 Statistics of refined gasoline produced from crude petroleum.
.111 Straight-run gasoline statistics.
.112 Cracked gasoline statistics.
.12 Natural gasoline statistics.
.125 Statistics of liquefied gas (propane-butane) production.
.2 Illuminating oil statistics.
.3 Gas oil statistics.
.4 Fuel oil statistics.
.41 Residuum fuel oil statistics.
.42 Diesel oil statistics.
.5 Lubricating oil and grease statistics.
.6 Paraffin wax statistics.
.7 Asphalt and road oil statistics.
.8 Petroleum coke statistics.
.9 Other statistics pertaining to refined petroleum products.
.91 Statistics of industrial consumers of petroleum products.
.92 Statistics of domestic consumers of petroleum products.
915. Natural gas production and consumption statistics.
.5 Statistics of the natural gasoline industry. (See also under 914.12.)
.6 Statistics of the carbon black industry.
916. Shale and shale oil production and consumption statistics.
917. Natural asphalt production and consumption statistics.
918. Mineral wax production and consumption statistics.
919. Other statistics pertaining to the petroleum and related industries.
.1 Commodity price index numbers.
.2 Wage scale index numbers.
920. Oil company finance, organization, and control.
.1 Development and exploration companies.
.2 Oil producing companies.
.3 Oil transportation companies.
.4 Oil refining companies.
.5 Oil marketing companies.
.6 Shale oil companies.
.7 Natural asphalt producing companies.
.8 Mineral wax producing companies.
.9 Other types of companies engaged in the oil business.
.91 Oil company financing and underwriting institutions.
.92 Oil industry supply companies.
921. Types and forms of oil companies and associations of individuals engaged in the oil industry.
.1 Partnerships.
.2 Joint stock companies.
.3 "Unit" companies.
.4 Oil trusts.
922. Oil company organization and finance.
.1 Incorporation.
.2 Promotion.
.21 Oil company prospectuses.
.3 Underwriting.
.4 Selling stock.
923. Oil company securities and methods of transfer.
.1 Oil stocks.
.2 Oil company bonds.
.3 Oil company debentures.
.4 Oil company notes.
.5 Oil security markets and exchanges and their customs.
924. Integration of the oil industry and its effects.
.1 Formation of trusts. (See also under 921.4.)
.2 Monopolies, their advantages and disadvantages.
.3 Control of production and markets.
925. Financial risks involved in the petroleum and allied industries.
.1 Interest rates suitable for oil industry investments.
926. Dividends and profits in the petroleum and related industries.
.5 Amortization of capital invested in the petroleum and related industries.
930. Management of oil companies and related organizations.
.1 Management of development and exploration companies.
.2 Management of oil producing companies.
.3 Management of natural gas companies.

[19] Each of the numbers under 914. may be further subdivided as follows:
914.5 Lubricating oil and grease statistics.
.51 Lubricating oil production statistics.
.52 Lubricating oil storage statistics.
.53 Lubricating oil price statistics.
.54 Statistics of lubricating oil exports from the United States.
.55 Statistics of lubricating oil imports into the United States.

.4 Management of oil refining companies.
.5 Management of oil marketing companies.
.6 Management of shale oil companies.
.7 Management of natural asphalt companies.
.8 Management of mineral wax producing companies.

931. Principles of management as applied to the petroleum and related industries.

932. Organization of oil and gas companies.
.1 Principles of organization.
.2 Organization diagrams.

933. Report systems.

934. Labor management.
.1 Labor organizations and their influence.
.11 Labor unions, their organization and aims.
.12 Strikes, their cause and control.
.13 Working agreements and contracts.
.2 Payment of labor.
.21 According to time worked.
.22 According to amount of work done.
.221 Piece-rate systems.
.222 Bonus and premium plans.
.223 Contract systems.
.23 Payment according to value of product.
.3 Employee welfare.
.31 Health: hospitals, working conditions, sanitation, safety, accident prevention, and first aid.
.311 Oil company medical departments and establishments; hospitals.
.312 Oil industry working conditions from health standpoint; occupational diseases.
.313 Sanitation in oil fields and refineries.
.314 Safety and accident prevention in oil industry operations.
.315 First-aid to injured persons in oil industry accidents.
.32 Recreation: clubs, sports, amusements, employee vacations.
.33 Insurance: accident, sickness, life, old age, unemployment.
.34 Remuneration for services: wage scales, bonuses, prizes, pensions, profit-sharing plans. (See also under 934.2.)
.35 Education and training: industrial schools; oil company personnel training plans.
.36 Living conditions in oil industry communities: employees' homes, gardens, and other domestic facilities and conveniences.

935. Personnel work in the petroleum and related industries.
.1 Personnel department organization and methods.
.2 Selection and employment of personnel.
.3 Promotion and transfer of personnel.
.4 Discharge of personnel.
.5 Personnel records.
.6 Oil company personnel publications.
.8 Personnel policies in other industries.

936. Conservation of supplies, materials, and power in the petroleum and related industries.

937. Plant maintenance.

938. Insurance requirements of companies engaging in the petroleum and related industries.
.1 Fire insurance.
.2 Employers' liability insurance.

939. Other data on management of oil industry enterprises.

940. Cost-accounting for the petroleum and related industries: office methods and records.
.1 Cost-accounting for oil producers.
.2 Cost-accounting for the oil transportation industries.
.3 Cost-accounting for oil refineries.
.4 Cost-accounting for shale oil enterprises.

941. Book-keeping and accounting for the petroleum and related industries.
.1 The books of account.
.2 Accounting systems.
.3 Balance sheets.
.4 Depreciation accounting.
.5 Depletion accounting.
.6 Tax accounting.
.7 Auditing.

942. Cost-keeping methods and forms.

943. Time-keeping and payment of labor; methods and records.

944. Store-keeping and purchasing methods and records.
.1 Purchasing.
.2 Store-keeping.

945. Production records.

946. Sales records.

947. Preparation of administrative statements and annual reports.

948. Office systems and equipment.
.1 Office lighting and ventilation.
.2 Office furniture.
.3 Office equipment and appliances.
.4 Office filing systems.

949. Other data on cost-accounting and office methods and systems.

950. Valuation of plant and property for the petroleum and related industries.
.1 Valuation formulae, tables, etc.
.11 For computation of present value of future income.
.2 Methods of conducting examinations for appraisal purposes.
.3 Valuation reports: form and technique.
.4 Valuation for income tax purposes.
.5 Valuation for sale or purchase.
.6 Valuation for consolidations.
.7 Valuation for insurance purposes.
.8 Oil stock and security valuation.

951. Appraisal of oil field plant and property.
.1 Estimating future oil production and economic life.
.11 By porosity and saturation computation; formation volume method.
.12 By barrel-day value method.
.13 By decline curve method.
.14 By use of productivity indices and successive bottom-hole pressure measurements.
.2 Estimating cost of future production.
.21 Estimating cost of new development.
.3 Estimating future selling price of oil.
.4 Estimating residual value of land.
.5 Valuation of oil field plant.

952. Appraisal of natural gas properties. (Subdivide as under 951. with following additions:)
.6 Appraisal of natural gasoline extraction plants.
.7 Appraisal of carbon black plants.

953. Appraisal of pipe line and storage facilities.

954. Appraisal of refinery plant and property.

955. Appraisal of marketing plant, property, and facilities.

956. Appraisal of shale oil properties.

957. Appraisal of natural asphalt properties.

958. Appraisal of mineral wax properties.

959. Other data on valuation of plant and property for the petroleum and related industries.

960. Marketing of petroleum and its products: economic influence of market conditions on the petroleum industry.
.1 Marketing of naphthas.
.11 Benzine.
.12 Gasoline.
.13 Engine distillate.
.2 Marketing of illuminating oils.
.21 Kerosene.
.22 Export oil.
.23 Mineral seal oil.
.24 Signal oil.
.25 Gas oil.
.3 Marketing of lubricants and related oils.
.31 Engine oils.
.32 Automobile oils.
.33 Cylinder oils.
.34 Machine oils.
.35 Spindle oils.
.36 Flushing oils.
.37 Cutting oils.
.38 Transformer oils.
.39 Other lubricating oils and related oils.
.4 Fuel oil.
.45 Diesel oil.
.5 Paraffin wax.
.6 Asphalt and road oils.
.7 Coke.
.8 Greases.
.9 Other petroleum products.
.91 Petrolatum and medicinal oil products.
.92 Turpentine substitutes.
.93 Rubber substitutes.
.94 Candles.

961. Marketing methods and systems.
.1 Direct marketing by producer or refiner.
.11 Through sales offices and agencies to large consumers.
.12 Through service stations to small consumers.
.2 Indirect marketing through middlemen and jobbers.
.21 Exporters and importers.
.3 Advertising.

962. Sales organizations and sales management.

963. Marketing equipment.
.1 Transportation equipment.
.2 Service station equipment.

EDITOR'S NOTE: Section 900 to 999. will be completed in the next installment of the Decimal System which will appear as Part 6 in the June, 1939, issue.

PISTON SPEED, FT. PER HOUR

Stroke, in.	Revolutions per minute														
	600	700	800	900	1000	1200	1400	1600	1800	2000	2200	2400	2600	2800	3000
3	18,000	21,000	**24,000**	**27,000**	**30,000**	**36,000**	**42,000**	**48,000**	**54,000**	**60,000**	66,000	72,000	78,000	84,000	90,000
3¼	19,500	22,750	**26,000**	**29,250**	**32,500**	**39,000**	**45,500**	**52,000**	**58,500**	65,000	71,500	78,000	84,500	91,000	97,500
3½	21,000	**24,500**	**28,000**	**31,500**	**35,000**	**42,000**	**49,000**	**56,000**	63,000	70,000	77,000	84,000	91,000	98,000	
3¾	22,500	**26,250**	**30,000**	**33,750**	**37,500**	**45,000**	**52,500**	**60,000**	67,500	75,000	82,500	90,000	97,500		
4	**24,000**	**28,000**	**32,000**	**36,000**	**40,000**	**48,000**	**56,000**	64,000	72,000	80,000	88,000	96,000			
4¼	**25,500**	**29,750**	**34,000**	**38,250**	**42,500**	**51,000**	**59,500**	68,000	76,500	85,000	93,500				
4½	**27,000**	**31,500**	**36,000**	**40,500**	**45,000**	**54,000**	63,000	72,000	81,000	90,000	99,000				
4¾	**28,500**	**33,250**	**38,000**	**42,750**	**47,500**	**57,000**	66,500	76,000	85,500	95,000					
5	**30,000**	**35,000**	**40,000**	**45,000**	**50,000**	**60,000**	70,000	80,000	90,000						
5¼	**31,500**	**36,750**	**42,000**	**47,250**	**52,500**	63,000	73,500	84,000	94,500						
5½	**33,000**	**38,500**	**44,000**	**49,500**	**55,000**	66,000	77,000	88,000	99,000						
5¾	**34,500**	**40,250**	**46,000**	**51,750**	**57,500**	69,000	80,500	92,000							
6	**36,000**	**42,000**	**48,000**	**54,000**	**60,000**	72,000	84,000	96,000							
6½	**39,000**	**45,500**	**52,000**	**58,500**	65,000	78,000	91,000								
7	**42,000**	**49,000**	**56,000**	63,000	70,000	84,000	98,000								
7½	**45,000**	**52,500**	**60,000**	67,500	75,000	90,000									
8	**48,000**	**56,000**	64,000	72,000	80,000	96,000									
8½	**51,000**	**59,500**	68,000	76,500	85,000										
9	**54,000**	63,000	72,000	81,000	90,000										
9½	**57,000**	66,500	76,000	85,500	95,000										
10	**60,000**	70,000	80,000	90,000											
10½	63,000	73,500	84,000	94,500											
11	66,000	77,000	88,000	99,000											
12	72,000	84,000	96,000												
13	78,000	91,000													
14	84,000	98,000													
15	90,000														
16	96,000														
18															
20															
22															
24															
26															
28															
30															
32															
34															
36															
40															
48															
60															

Example: An engine that has a 12-in. stroke operates 24 hr. per day for 284 days at an average speed of 335 r.p.m. Find total distance traveled by one of the pistons.

Solution:

24 x 284 = 6816 hr.

Using table, opposite 12-in. stroke

300 r.p.m. gives 36,000 ft. per hr.
30 r.p.m. gives 3,600 ft. per hr.
5 r.p.m. gives 600 ft. per hr.

Total for 335 r.p.m. 40,200 ft. per hr.

40,200 x 6,816 = 274,003,200 ft.

= total distance traveled.

ON THE FINEST OIL FIELD MACHINERY

Brewster's Rig..*Another Example*

● Oil country production men are well acquainted with the ruggedness and efficiency of DIAMOND Roller Chains,—their ease of maintenance anywhere, in any service .... Machinery manufacturers have had 48 years of proof that DIAMOND Drives insure maximum performance.

On Brewster Rigs, compact and sturdy in design, the engineers have made good use of DIAMOND Roller Chains in midship transmission and other drives .... Another example of DIAMOND "on the finest oil field machinery." DIAMOND CHAIN & MFG. CO., 441 Kentucky Avenue, Indianapolis, Indiana. Tulsa, Oklahoma: 2238 Terwilleger Boulevard.

DIAMOND
ROLLER CHAINS

TRADE MARK

CAPACITY OF WIDE DRUM OF LARGE A.P.I. STANDARD[1] SAND REEL, FT. OF LINE

Total depth[2] of winding, in.	Size of line, in.								
	1/4	9/32	5/16	3/8	7/16	1/2	9/16	5/8	3/4
1/4	305								
1/2	624	497	403	279	206	158			
3/4	955	759	615	427	314	242	190	154	106
1	1297	1032	836	581	427	327	259	209	146
1 1/4	1654	1316	1064	739	545	418	329	267	185
1 1/2	2021	1608	1303	903	665	511	403	327	226
1 3/4	2401	1911	1548	1075	790	607	478	387	269
2	2796	2225	1801	1250	920	706	557	451	312
2 1/4	3200	2547	2062	1431	1054	807	638	518	358
2 1/2	3618	2880	2331	1618	1191	914	720	584	405
2 3/4	4048	3222	2609	1810	1333	1022	806	655	452
3	4492	3574	2893	2009	1479	1135	895	725	502
3 1/4	4948	3937	3188	2213	1630	1250	986	799	554
3 1/2	5416	4309	3488	2422	1784	1368	1078	874	605
3 3/4	5896	4691	3798	2636	1942	1488	1174	953	658
4	6388	5084	4115	2857	2105	1613	1272	1032	715
4 1/4	6894	5485	4441	3082	2271	1740	1373	1130	771
4 1/2	7411	5898	4775	3313	2441	1872	1476	1198	828
4 3/4	7943	6320	5116	3551	2616	2005	1580	1284	888
5	8484	6751	5466	3793	2794	2143	1688	1371	948
5 1/4	9040	7194	5824	4042	2977	2281	1795	1460	1011
5 1/2	9609	7644	6189	4295	3164	2425	1913	1553	1075
5 3/4	10188	8107	6563	4556	3356	2571	2028	1645	1138
6	10781	8579	6945	4820	3550	2722	2146	1741	1205
6 1/4		9060	7336	5091	3750	2874	2266	1839	1274
6 1/2		9550	7734	5367	3952	3030	2389	1939	1342
6 3/4		10053	8140	5649	4160	3190	2514	2041	1412
7		10563	8553	5936	4372	3351	2643	2144	1484
7 1/4		11084	8975	6229	4588	3517	2773	2250	1558
7 1/2			9405	6527	4808	3685	2905	2358	1632
7 3/4			9844	6832	5032	3857	3041	2468	1707
8			10289	7141	5260	4031	3179	2580	1786
8 1/4			10743	7456	5492	4210	3320	2694	1865
8 1/2			11206	7778	5728	4391	3462	2809	1944
8 3/4				8104	5968	4575	3608	2928	2026
9				8436	6213	4761	3755	3047	2108
9 1/4				8772	6462	4953	3906	3169	2194
9 1/2				9117	6715	5147	4059	3294	2280
9 3/4				9465	6971	5343	4213	3419	2367
10				9820	7233	5543	4371	3548	2454
10 1/4				10179	7497	5745	4532	3677	2545
10 1/2				10545	7768	5953	4695	3810	2636
10 3/4				10915	8039	6162	4861	3944	2729
11					8318	6374	5027	4079	2823
11 1/4					8597	6590	5197	4218	2919
11 1/2					8885	6810	5370	4357	3015
11 3/4					9173	7033	5545	4501	3114
12					9468	7257	5721	4645	3212
12 1/4					9765	7485	5903	4791	3315
12 1/2					10068	7716	6085	4938	3418
12 3/4					10375	7951	6270	5089	3521
13					10683	8188	6457	5241	3627

[1]Wide drum diameter, 12 in.; width, 24 in.; flange diameter, 40 in.
[2]Distance from shaft to outside surface of outer layer.

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From draw works to crown block, and back again you see "Flex-Set" Preformed Yellow Strand.

You know that the cable on a rotary rig must be tough —must take it on the chin, and like it. In fact, you know that the only cable that will ever give genuinely economical service is the very best cable you can buy.

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Looking up through your rotary rig, and seeing "Flex-Set" Preformed Yellow Strand doing the heavy work, is proof positive that the economy of your operation is also looking up.

BRODERICK & BASCOM ROPE CO., ST. LOUIS
Houston Branch: 1311 Palmer St., Houston, Texas

U-16R5

THE CONTINENTAL SUPPLY CO. Mid-Continent and Rocky Mountain Distributors

"Flex-Set" Preformed YELLOW STRAND

LUBRICANTS FOR ROLLER-TYPE BEARINGS

	Smaller than 6-in. O. D.				6-in. O. D. or larger			
	Operating temperature of bearing				Operating temperature of bearing			
	Below 32°F. (0°C.)	32°F. (0°C.) to 122°F. (50°C.)	122°F. (50°C.) to 175°F. (79.4°C.)	Above 175°F. (79.4°C.)	Below 32°F. (0°C.)	32°F. (0°C.) to 122°F. (50°C.)	122°F. (50°C.) to 175°F. (79.4°C.)	Above 175°F. (79.4°C.)
When lubricant is subject to presence of water:								
500 r.p.m. or less oil		III	IV	V		III	IV	V
grease		C	F	*		C	F	*
500 to 1000 r.p.m. oil		III	IV	V		III	IV	V
grease		C	F	*		*	*	*
1000 r.p.m. or more oil		III	IV	V		III	IV	V
grease		C	F	*		*	*	*
When lubricant will not be in contact with water:								
500 r.p.m. or less oil	I	III	IV	V	I	III	IV	V
grease	A	D	G	*	A	D	G	*
500 to 1000 r.p.m. oil	I	III	IV	V	I	III	IV	V
grease	A	D	G	*	*	*	*	*
1000 r.p.m. or more oil	II	III	IV	V	II	III	IV	V
grease	B	E	G	*	*	*	*	*

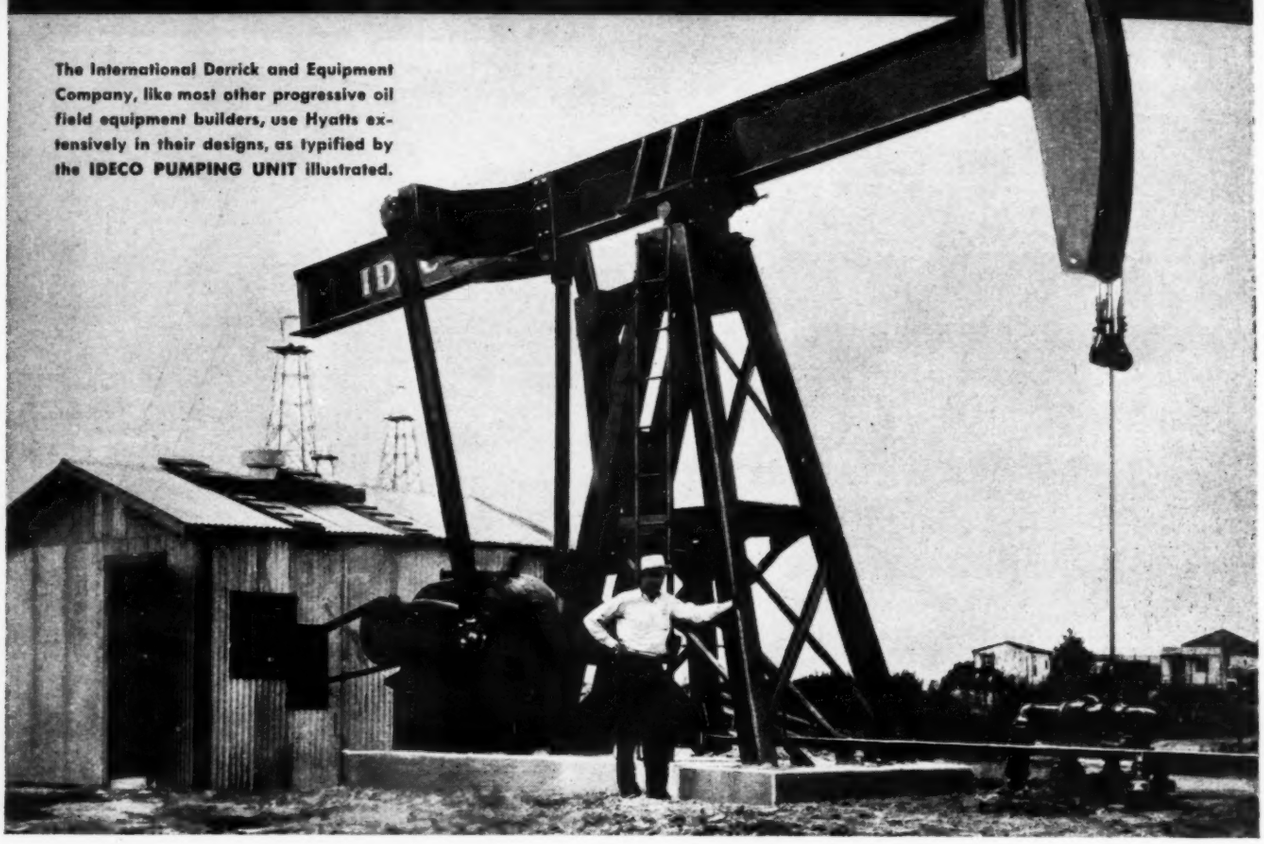
*Use of grease not recommended.

Specifications of lubricants

Oils				Greases		
Symbol	Type of oil	Viscosity of oil, Saybolt Universal seconds		Symbol	Type of grease	Consistency of grease at 75°F., Karns-Maag method
		at 100°F.	at 210°F.			
I	Neutral mineral	75–500	.....	A	Lime or soda base	20.0 to 50.0
II	Neutral mineral	75–300	.....	B	Soda base—short fibre	30.0 to 50.0
III	Neutral mineral	100–700	.....	C	Lime base	20.0 to 40 0
IV	Neutral mineral	.....	60–100	D	Lime or soda base	20.0 to 40.0
V	Neutral mineral	.....	100 or more	E	Soda base	20.0 to 40.0
				F	Lime base	15.0 to 30 0
				G	Soda base	15.0 to 30.0

Note: Lubricants conforming to these specifications are available from most leading oil marketers.

Good Mixers
IN ANY COMPANY



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HYATT *Roller Bearings*

CAPACITY OF MUD PIT, CU. FT. PER IN. DEPTH

Length, ft., in.

Width, ft. in.	6 0	6 1	6 2	6 3	6 4	6 5	6 6	6 7	6 8	6 9	6 10	6 11
4 0	2.00	2.03	2.06	2.08	2.11	2.14	2.17	2.19	2.22	2.25	2.28	2.31
4 1	2.04	2.07	2.10	2.13	2.16	2.18	2.21	2.24	2.27	2.30	2.33	2.35
4 2	2.08	2.11	2.14	2.17	2.20	2.23	2.26	2.29	2.31	2.34	2.37	2.40
4 3	2.13	2.15	2.18	2.21	2.24	2.27	2.30	2.33	2.36	2.39	2.42	2.45
4 4	2.17	2.20	2.23	2.26	2.29	2.32	2.35	2.38	2.41	2.44	2.47	2.50
4 5	2.21	2.24	2.27	2.30	2.33	2.36	2.39	2.42	2.45	2.48	2.52	2.55
4 6	2.25	2.28	2.31	2.34	2.38	2.41	2.44	2.47	2.50	2.53	2.56	2.59
4 7	2.29	2.32	2.36	2.39	2.42	2.45	2.48	2.51	2.55	2.58	2.61	2.64
4 8	2.33	2.37	2.40	2.43	2.46	2.50	2.53	2.56	2.59	2.62	2.66	2.69
4 9	2.37	2.41	2.44	2.47	2.51	2.54	2.57	2.61	2.64	2.67	2.70	2.74
4 10	2.42	2.45	2.48	2.52	2.55	2.58	2.62	2.65	2.69	2.72	2.75	2.79
4 11	2.46	2.49	2.53	2.56	2.59	2.63	2.66	2.70	2.73	2.77	2.80	2.83
5 0	2.50	2.53	2.57	2.60	2.64	2.67	2.71	2.74	2.78	2.81	2.85	2.88
5 1	2.54	2.58	2.61	2.65	2.68	2.72	2.75	2.79	2.82	2.86	2.89	2.93
5 2	2.58	2.62	2.66	2.69	2.73	2.76	2.80	2.83	2.87	2.91	2.94	2.98
5 3	2.62	2.66	2.70	2.73	2.77	2.81	2.84	2.88	2.92	2.95	2.99	3.03
5 4	2.67	2.70	2.74	2.78	2.81	2.85	2.89	2.93	2.96	3.00	3.04	3.07
5 5	2.71	2.75	2.78	2.82	2.86	2.90	2.93	2.97	3.01	3.05	3.08	3.12
5 6	2.75	2.79	2.83	2.86	2.90	2.94	2.98	3.02	3.06	3.09	3.13	3.17
5 7	2.79	2.83	2.87	2.91	2.95	2.99	3.02	3.06	3.10	3.14	3.18	3.22
5 8	2.83	2.87	2.91	2.95	2.99	3.03	3.07	3.11	3.15	3.19	3.23	3.27
5 9	2.88	2.91	2.95	2.99	3.03	3.07	3.11	3.15	3.19	3.23	3.27	3.31
5 10	2.92	2.96	3.00	3.04	3.08	3.12	3.16	3.20	3.24	3.28	3.32	3.36
5 11	2.96	3.00	3.04	3.08	3.12	3.16	3.20	3.25	3.29	3.33	3.37	3.41
6 0	3.00	3.04	3.08	3.12	3.17	3.21	3.25	3.29	3.33	3.37	3.42	3.46
6 1		3.08	3.13	3.17	3.21	3.25	3.30	3.34	3.38	3.42	3.46	3.51
6 2			3.17	3.21	3.25	3.30	3.34	3.38	3.43	3.47	3.51	3.55
6 3				3.26	3.30	3.34	3.39	3.43	3.47	3.52	3.56	3.60
6 4					3.34	3.39	3.43	3.47	3.52	3.56	3.61	3.65
6 5						3.43	3.48	3.52	3.56	3.61	3.65	3.70
6 6							3.52	3.57	3.61	3.66	3.70	3.75
6 7								3.61	3.66	3.70	3.75	3.79
6 8									3.70	3.75	3.80	3.84
6 9										3.80	3.84	3.89
6 10											3.89	3.94
6 11												3.99

Width, ft. in.	7 0	7 1	7 2	7 3	7 4	7 5	7 6	7 7	7 8	7 9	7 10	7 11
4 0	2.33	2.36	2.39	2.42	2.44	2.47	2.50	2.53	2.56	2.58	2.61	2.64
4 1	2.38	2.41	2.44	2.47	2.50	2.52	2.55	2.58	2.61	2.64	2.67	2.69
4 2	2.43	2.46	2.49	2.52	2.55	2.58	2.60	2.63	2.66	2.69	2.72	2.75
4 3	2.48	2.51	2.54	2.57	2.60	2.63	2.66	2.69	2.72	2.74	2.77	2.80
4 4	2.53	2.56	2.59	2.62	2.65	2.68	2.71	2.74	2.77	2.80	2.83	2.86
4 5	2.58	2.61	2.64	2.67	2.70	2.73	2.76	2.79	2.82	2.85	2.88	2.91
4 6	2.63	2.66	2.69	2.72	2.75	2.78	2.81	2.84	2.88	2.91	2.94	2.97
4 7	2.67	2.71	2.74	2.77	2.80	2.83	2.86	2.90	2.93	2.96	2.99	3.02
4 8	2.72	2.75	2.79	2.82	2.85	2.88	2.92	2.95	2.98	3.01	3.05	3.08
4 9	2.77	2.80	2.84	2.87	2.90	2.94	2.97	3.00	3.03	3.07	3.10	3.13
4 10	2.82	2.85	2.89	2.92	2.95	2.99	3.02	3.05	3.09	3.12	3.16	3.19
4 11	2.87	2.90	2.94	2.97	3.00	3.04	3.07	3.11	3.14	3.18	3.21	3.24
5 0	2.92	2.95	2.99	3.02	3.06	3.09	3.12	3.16	3.19	3.23	3.26	3.30
5 1	2.97	3.00	3.04	3.07	3.11	3.14	3.18	3.21	3.25	3.28	3.32	3.35
5 2	3.01	3.05	3.09	3.12	3.16	3.19	3.23	3.27	3.30	3.34	3.37	3.41
5 3	3.06	3.10	3.14	3.17	3.21	3.24	3.28	3.32	3.35	3.39	3.43	3.46
5 4	3.11	3.15	3.19	3.22	3.26	3.30	3.33	3.37	3.41	3.44	3.48	3.52
5 5	3.16	3.20	3.23	3.27	3.31	3.35	3.39	3.42	3.46	3.50	3.54	3.57
5 6	3.21	3.25	3.28	3.32	3.36	3.40	3.44	3.48	3.51	3.55	3.59	3.63
5 7	3.26	3.30	3.33	3.37	3.41	3.45	3.49	3.53	3.57	3.61	3.64	3.68
5 8	3.31	3.34	3.38	3.42	3.46	3.50	3.54	3.58	3.62	3.66	3.70	3.74
5 9	3.35	3.39	3.43	3.47	3.51	3.55	3.59	3.63	3.67	3.71	3.75	3.79
5 10	3.40	3.44	3.48	3.52	3.56	3.61	3.65	3.69	3.73	3.77	3.81	3.85
5 11	3.45	3.49	3.53	3.57	3.62	3.66	3.70	3.74	3.78	3.82	3.86	3.90
6 0	3.50	3.54	3.58	3.62	3.67	3.71	3.75	3.79	3.83	3.87	3.92	3.96
6 1	3.55	3.59	3.63	3.68	3.72	3.76	3.80	3.84	3.89	3.93	3.97	4.01
6 2	3.60	3.64	3.68	3.73	3.77	3.81	3.85	3.90	3.94	3.98	4.03	4.07
6 3	3.65	3.69	3.73	3.78	3.82	3.86	3.91	3.95	3.99	4.04	4.08	4.12
6 4	3.69	3.74	3.78	3.83	3.87	3.91	3.96	4.00	4.05	4.09	4.13	4.18
6 5	3.74	3.79	3.83	3.88	3.92	3.97	4.01	4.05	4.10	4.14	4.19	4.23
6 6	3.79	3.84	3.88	3.93	3.97	4.02	4.06	4.11	4.15	4.20	4.24	4.29
6 7	3.84	3.89	3.93	3.98	4.02	4.07	4.11	4.16	4.21	4.25	4.30	4.34
6 8	3.89	3.94	3.98	4.03	4.07	4.12	4.17	4.21	4.26	4.31	4.35	4.40
6 9	3.94	3.98	4.03	4.08	4.13	4.17	4.22	4.27	4.31	4.36	4.41	4.45
6 10	3.99	4.03	4.08	4.13	4.18	4.22	4.27	4.32	4.37	4.41	4.46	4.51
6 11	4.03	4.08	4.13	4.18	4.23	4.27	4.32	4.37	4.42	4.47	4.52	4.56
7 0	4.08	4.13	4.18	4.23	4.28	4.32	4.37	4.42	4.47	4.52	4.57	4.62
7 1		4.18	4.23	4.28	4.33	4.38	4.43	4.48	4.53	4.57	4.62	4.67
7 2			4.28	4.33	4.38	4.43	4.48	4.53	4.58	4.63	4.68	4.73
7 3				4.38	4.43	4.48	4.53	4.58	4.63	4.68	4.73	4.78
7 4					4.48	4.53	4.58	4.63	4.69	4.74	4.79	4.84
7 5						4.58	4.64	4.69	4.74	4.79	4.84	4.89
7 6							4.69	4.74	4.79	4.84	4.90	4.95
7 7								4.79	4.84	4.90	4.95	5.00
7 8									4.90	4.95	5.00	5.06
7 9										5.01	5.06	5.11
7 10											5.11	5.17
7 11												5.22

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CAPACITY OF MUD PIT, CU. FT. PER IN. DEPTH

Width, ft., in.	Length, ft., in.																							
	8 0	8 1	8 2	8 3	8 4	8 5	8 6	8 7	8 8	8 9	8 10	8 11	9 0	9 1	9 2	9 3	9 4	9 5	9 6	9 7	9 8	9 9	9 10	9 11
4 0	2.67	2.69	2.72	2.75	2.78	2.81	2.83	2.86	2.89	2.92	2.94	2.97	3.00	3.03	3.06	3.08	3.11	3.14	3.17	3.19	3.22	3.25	3.28	3.31
4 1	2.72	2.75	2.78	2.81	2.84	2.86	2.89	2.92	2.95	2.98	3.01	3.03	3.06	3.09	3.12	3.15	3.18	3.20	3.23	3.26	3.29	3.32	3.35	3.37
4 2	2.78	2.81	2.84	2.86	2.89	2.92	2.95	2.98	3.01	3.04	3.07	3.10	3.12	3.15	3.18	3.21	3.24	3.27	3.30	3.33	3.36	3.39	3.41	3.44
4 3	2.83	2.86	2.89	2.92	2.95	2.98	3.01	3.04	3.07	3.10	3.13	3.16	3.19	3.22	3.25	3.28	3.31	3.34	3.36	3.39	3.42	3.45	3.48	3.51
4 4	2.89	2.92	2.95	2.98	3.01	3.04	3.07	3.10	3.13	3.16	3.19	3.22	3.25	3.28	3.31	3.34	3.37	3.40	3.43	3.46	3.49	3.52	3.55	3.58
4 5	2.94	2.98	3.01	3.04	3.07	3.10	3.13	3.16	3.19	3.22	3.25	3.28	3.31	3.34	3.37	3.40	3.44	3.47	3.50	3.53	3.56	3.59	3.62	3.65
4 6	3.00	3.03	3.06	3.09	3.12	3.16	3.19	3.22	3.25	3.28	3.31	3.34	3.38	3.41	3.44	3.47	3.50	3.53	3.56	3.59	3.62	3.66	3.69	3.72
4 7	3.06	3.09	3.12	3.15	3.18	3.21	3.25	3.28	3.31	3.34	3.37	3.41	3.44	3.47	3.50	3.53	3.56	3.60	3.63	3.66	3.69	3.72	3.76	3.79
4 8	3.11	3.14	3.18	3.21	3.24	3.27	3.31	3.34	3.37	3.40	3.44	3.47	3.50	3.53	3.56	3.60	3.63	3.66	3.69	3.73	3.76	3.79	3.82	3.86
4 9	3.17	3.20	3.23	3.27	3.30	3.33	3.36	3.40	3.43	3.46	3.50	3.53	3.56	3.60	3.63	3.66	3.69	3.73	3.76	3.79	3.83	3.86	3.89	3.93
4 10	3.22	3.26	3.29	3.32	3.36	3.39	3.42	3.46	3.49	3.52	3.56	3.59	3.63	3.66	3.69	3.73	3.76	3.79	3.83	3.86	3.89	3.93	3.96	3.99
4 11	3.28	3.31	3.35	3.38	3.41	3.45	3.48	3.52	3.55	3.59	3.62	3.65	3.69	3.72	3.76	3.79	3.82	3.86	3.89	3.93	3.96	3.99	4.03	4.06
5 0	3.33	3.37	3.40	3.44	3.47	3.51	3.54	3.58	3.61	3.65	3.68	3.72	3.75	3.78	3.82	3.85	3.89	3.92	3.96	3.99	4.03	4.06	4.10	4.13
5 1	3.39	3.42	3.46	3.49	3.53	3.57	3.60	3.64	3.67	3.71	3.74	3.78	3.81	3.85	3.88	3.92	3.95	3.99	4.02	4.06	4.09	4.13	4.17	4.20
5 2	3.44	3.48	3.52	3.55	3.59	3.62	3.66	3.70	3.73	3.77	3.80	3.84	3.88	3.91	3.95	3.98	4.02	4.05	4.09	4.13	4.16	4.20	4.23	4.27
5 3	3.50	3.54	3.57	3.61	3.65	3.68	3.72	3.76	3.79	3.83	3.86	3.90	3.94	3.97	4.01	4.05	4.08	4.12	4.16	4.19	4.23	4.27	4.30	4.34
5 4	3.56	3.59	3.63	3.67	3.70	3.74	3.78	3.81	3.85	3.89	3.93	3.96	4.00	4.04	4.07	4.11	4.15	4.19	4.22	4.26	4.30	4.33	4.37	4.41
5 5	3.61	3.65	3.69	3.72	3.76	3.80	3.84	3.87	3.91	3.95	3.99	4.02	4.06	4.10	4.14	4.18	4.21	4.25	4.29	4.33	4.36	4.40	4.44	4.48
5 6	3.67	3.70	3.74	3.78	3.82	3.86	3.90	3.93	3.97	4.01	4.05	4.09	4.12	4.16	4.20	4.24	4.28	4.32	4.35	4.39	4.43	4.47	4.51	4.55
5 7	3.72	3.76	3.80	3.84	3.88	3.92	3.95	3.99	4.03	4.07	4.11	4.15	4.19	4.23	4.27	4.30	4.34	4.38	4.42	4.46	4.50	4.54	4.58	4.61
5 8	3.78	3.82	3.86	3.90	3.94	3.97	4.01	4.05	4.09	4.13	4.17	4.21	4.25	4.29	4.33	4.37	4.41	4.45	4.49	4.53	4.56	4.60	4.64	4.68
5 9	3.83	3.87	3.91	3.95	3.99	4.03	4.07	4.11	4.15	4.19	4.23	4.27	4.31	4.35	4.39	4.43	4.47	4.51	4.55	4.59	4.63	4.67	4.71	4.75
5 10	3.89	3.93	3.97	4.01	4.05	4.09	4.13	4.17	4.21	4.25	4.29	4.33	4.37	4.42	4.46	4.50	4.54	4.58	4.62	4.66	4.70	4.74	4.78	4.82
5 11	3.94	3.99	4.03	4.07	4.11	4.15	4.19	4.23	4.27	4.31	4.36	4.40	4.44	4.48	4.52	4.56	4.60	4.64	4.68	4.73	4.77	4.81	4.85	4.89
6 0	4.00	4.04	4.08	4.13	4.17	4.21	4.25	4.29	4.33	4.38	4.42	4.46	4.50	4.54	4.58	4.63	4.67	4.71	4.75	4.79	4.83	4.88	4.92	4.96
6 1	4.06	4.10	4.14	4.18	4.22	4.27	4.31	4.35	4.39	4.44	4.48	4.52	4.56	4.60	4.65	4.69	4.73	4.77	4.82	4.86	4.90	4.94	4.98	5.03
6 2	4.11	4.15	4.20	4.24	4.28	4.33	4.37	4.41	4.45	4.50	4.54	4.58	4.62	4.67	4.71	4.75	4.80	4.84	4.88	4.92	4.97	5.01	5.05	5.10
6 3	4.17	4.21	4.25	4.30	4.34	4.38	4.43	4.47	4.51	4.56	4.60	4.64	4.69	4.73	4.77	4.82	4.86	4.90	4.95	4.99	5.03	5.08	5.12	5.16
6 4	4.22	4.27	4.31	4.35	4.40	4.44	4.49	4.53	4.57	4.62	4.66	4.71	4.75	4.79	4.84	4.88	4.93	4.97	5.01	5.06	5.10	5.15	5.19	5.23
6 5	4.28	4.32	4.37	4.41	4.46	4.50	4.55	4.59	4.63	4.68	4.72	4.77	4.81	4.86	4.90	4.95	4.99	5.04	5.08	5.12	5.17	5.21	5.26	5.30
6 6	4.33	4.38	4.42	4.47	4.51	4.56	4.60	4.65	4.69	4.74	4.78	4.83	4.88	4.92	4.97	5.01	5.06	5.10	5.15	5.19	5.24	5.28	5.33	5.37
6 7	4.39	4.43	4.48	4.53	4.57	4.62	4.66	4.71	4.75	4.80	4.85	4.89	4.94	4.98	5.03	5.07	5.12	5.17	5.21	5.26	5.30	5.35	5.39	5.44
6 8	4.44	4.49	4.54	4.58	4.63	4.68	4.72	4.77	4.81	4.86	4.91	4.95	5.00	5.05	5.09	5.14	5.19	5.23	5.28	5.32	5.37	5.42	5.46	5.51
6 9	4.50	4.55	4.59	4.64	4.69	4.73	4.78	4.83	4.88	4.92	4.97	5.02	5.06	5.11	5.16	5.20	5.25	5.30	5.34	5.39	5.44	5.48	5.53	5.58
6 10	4.56	4.60	4.65	4.70	4.75	4.79	4.84	4.89	4.94	4.98	5.03	5.08	5.13	5.17	5.22	5.27	5.31	5.36	5.41	5.46	5.50	5.55	5.60	5.65
6 11	4.61	4.66	4.71	4.76	4.80	4.85	4.90	4.95	5.00	5.04	5.09	5.14	5.19	5.24	5.28	5.33	5.38	5.43	5.48	5.52	5.57	5.62	5.67	5.72
7 0	4.67	4.72	4.76	4.81	4.86	4.91	4.96	5.01	5.06	5.10	5.15	5.20	5.25	5.30	5.35	5.40	5.44	5.49	5.54	5.59	5.64	5.69	5.74	5.78
7 1	4.72	4.77	4.82	4.87	4.92	4.97	5.02	5.07	5.12	5.16	5.21	5.26	5.31	5.36	5.41	5.46	5.51	5.56	5.61	5.66	5.71	5.76	5.80	5.85
7 2	4.78	4.83	4.88	4.93	4.98	5.03	5.08	5.13	5.18	5.23	5.28	5.33	5.38	5.42	5.47	5.52	5.57	5.62	5.67	5.72	5.77	5.82	5.87	5.92
7 3	4.83	4.88	4.93	4.98	5.03	5.09	5.14	5.19	5.24	5.29	5.34	5.39	5.44	5.49	5.54	5.59	5.64	5.69	5.74	5.79	5.84	5.89	5.94	5.99
7 4	4.89	4.94	4.99	5.04	5.09	5.14	5.19	5.25	5.30	5.35	5.40	5.45	5.50	5.55	5.60	5.65	5.70	5.75	5.81	5.86	5.91	5.96	6.01	6.06
7 5	4.94	5.00	5.05	5.10	5.15	5.20	5.25	5.31	5.36	5.41	5.46	5.51	5.56	5.61	5.67	5.72	5.77	5.82	5.87	5.92	5.97	6.03	6.08	6.13
7 6	5.00	5.05	5.10	5.16	5.21	5.26	5.31	5.36	5.42	5.47	5.52	5.57	5.62	5.68	5.73	5.78	5.83	5.89	5.94	5.99	6.04	6.09	6.15	6.20
7 7	5.06	5.11	5.16	5.21	5.27	5.32	5.37	5.42	5.48	5.53	5.58	5.63	5.69	5.74	5.79	5.85	5.90	5.95	6.00	6.06	6.11	6.16	6.21	6.27
7 8	5.11	5.16	5.22	5.27	5.32	5.38	5.43	5.48	5.54	5.59	5.64	5.70	5.75	5.80	5.86	5.90	5.96	6.02	6.07	6.12	6.18	6.23	6.28	6.34
7 9	5.17	5.22	5.27	5.33	5.38	5.44	5.49	5.54	5.60	5.65	5.70	5.76	5.81	5.87	5.92	5.97	6.03	6.08	6.14	6.19	6.24	6.30	6.35	6.40
7 10	5.22	5.28	5.33	5.39	5.44	5.49	5.55	5.60	5.66	5.71	5.77	5.82	5.87	5.93	5.98	6.04	6.09	6.15	6.20	6.26	6.31	6.36	6.42	6.47
7 11	5.28	5.33	5.39	5.44	5.50	5.55	5.61	5.66	5.72	5.77	5.83	5.88	5.94	5.99	6.05	6.10	6.16	6.21	6.27	6.32	6.38	6.43	6.49	6.54

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P 225.1
P 729.

Determination of Salts in Crude Oil

Part 5 (Concluded)

ANALYTICAL METHODS

By

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Biographical sketches and photographs of Messrs. Roberts and Stenzel can be found on page 35 of the January issue of *The Petroleum Engineer*, in connection with Part 1 of this series. A sketch and photograph of Mr. Eberz appear on page 42 of the March issue.

EXPERIMENTS similar to those described were also made with calcium chloride. The results are shown in Table 11. This salt is much less hydrolyzed than magnesium chloride, the extent of the hydrolysis ranging from 2 percent in the pure system (Experiments 35 and 37) to 10 percent in the crude oil (Experiments 25 and 28). The marked effects of the degree of dispersion of the salt are again shown by the first three experiments in the table.

Experiment 28 was performed to determine whether the rate at which the steam is passed through the oil is at all critical, but it can be seen that even when 2.5 times the prescribed rate was used, the hydrolysis was not altered.

Although the hydrolysis is of a low order compared with magnesium chloride, it is nevertheless a factor to be considered in a corrosivity appraisal, because the actual quantity of calcium salts present is usually considerably greater than that of magnesium salts.

The hydrolysis of the various salts in terms of HCl may be summarized as follows for pure oil systems:

Sodium chloride	Negligible
Calcium chloride	2%
Magnesium chloride	50%

The actual HCl evolution from a crude oil may be much greater, depending upon the amount and kind of acidic materials present. It is, of course, possible to distill hydrogen chloride from NaCl if the acid is sufficiently strong and non-volatile. Then again there may be alkaline substances present that would reduce the hydrolysis, so that the acid evolution may vary widely with different oils of the same salt content. Unless these factors are recognized, the variations in results on different oils may appear erratic and unintelligible.

That acidity of the oil is the most probable cause of the increased hydrolysis in crude oils is also indicated by the values for strong acidity, determined as described in the subsequent section on Free Acidity. From Fig. 5, in the section on Free Acidity, it can be seen that there is sufficient strong acid in both sample D876 and D877 to account for the increased magnesium chloride hydrolysis over that obtained with the purified system. This, of course, implies that this strong acidity is not appreciably extracted by the preliminary water washes (Experiment 21, Table 10) or even a dilute caustic wash (Experiment 22). Although positive confirmatory evidence has not yet been obtained, no other explanation fits the data more plausibly.

A further insight into the mechanism of HCl evolution can be gained from Figs. 3 and 4. During the distillations, fractions were taken at 250, 350, 450, 550, and 650°F. and separately titrated. The cumulative results in terms of percent hydrolysis were then plotted. The curves of Fig. 3 were obtained from the experiments in Table 10 in which magnesium chloride was added to the systems. Curve A (Experiment 21) is typical of the temperature-hydrolysis relationship for the crude oil sample D876. The results for Experiment 36 with White Oil are shown by the circles of Curve B, the triangles on the same curve being for the extended time distillation of Experiment 46. This graphically confirms the previously expressed conclusion that the rate of distillation has no marked effect on the total acid evolved, and it also does not appreciably alter the distribution. The extent of the hydrolysis is apparently entirely controlled by the temperature for a given oil system, as the steam rate has also been shown to be not critical.

Curve C represents Experiment 44, in which the quantity of magnesium chloride was reduced to one-tenth of that represented by Curve B, and shows that although the rate of hydrolysis in the White Oil is increased at the lower temperatures, the total hydrolysis is not markedly affected, in accord with the hypothesis previously outlined. On the other hand, the reduced concentration has a large influence on the hydrolysis when crude oil is used, as shown by Curve D (Experiment 45), which similarly had only one-tenth as much of the salt as the tests of Curve A. This increase has already been attributed to the acidity of the oil sample.

The curves of Fig. 4 show the cumulative hydrolysis values for calcium chloride. It will be noted that the relative acid evolution from the crude oil is much larger compared to that from

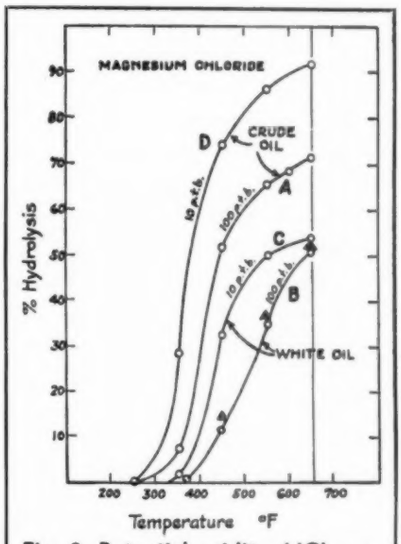

Fig. 3. Potential acidity. HCl evolution, steam distillation method

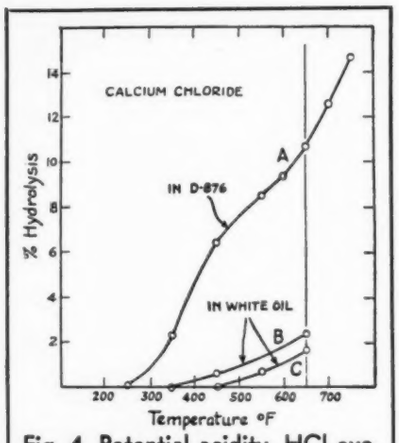

Fig. 4. Potential acidity. HCl evolution, steam distillation method

the purified oil than in the case of magnesium chloride, but the absolute values are much lower. Curve A represents Experiment 25, the distillation being continued to 750°F. in order to find the trend in the decomposition rate. It is apparent that the salt continues to hydrolyze with no decrease in rate before this temperature is reached, which is a factor to be considered in making corrosivity estimates for refinery conditions.

Curves B (Experiment 37) and C (Experiment 35) show the effect of the presence of distillate on the values obtained with the White Oil system, which is to shift the curves somewhat, owing probably to the sweeping-out effect of the distillate vapors. The effect, however, is small.

In general the effects of the various factors investigated are in qualitative accord with those found by Davis, Jones, and Neilson, and the quantitative differences are ascribable to the differences in the oil systems used. The importance of taking into account the degree of dispersion of the salts and the relation between the quantities of salts and acids present, in formulating conclusions from the experimental results, has been demonstrated by this work.

The results obtained by the distillation method for determining acid evolution indicate that the procedure is sound, neither the steam rate, the distillation rate, nor the distillate volume showing evidence of being critical factors, so that results should prove reproducible even for different operators. Because, as already noted, it has been found to show a reasonable correlation with refinery corrosion, it should prove to be a valuable adjunct to present laboratory methods for evaluating a crude oil in terms most useful to the refiner.

2. Free Acidity. There are two general methods for the determination of acidity of oils. One is to make an aqueous extraction of the oil and to titrate the extract to a predetermined endpoint. The conditions of extraction (such as temperature and degree of dispersion) and the nature of the extractant (distilled water, alkali, buffer, etc.) will of course markedly affect the results. When an alkaline extractant is used, an excess of alkali is generally present so that back titration with acid is usually made.

The other method is to titrate the acidity directly by adding the alkali in alcohol to the oil, to which has also been added a solvent, so that neutralization may proceed as far as possible in the oil phase. Such titrations in a single phase may be followed electrometrically, but if an indicator method is desired, a clear, oil-free phase such as a water-alcohol mixture must be present so that the indicator endpoint may be detected. In such a case it is difficult to determine whether the reaction occurs in the oil phase alone or whether extraction also plays a part.

An attempt to apply standard methods such as the A.S.T.M. method D-188-27T to crude oil leads to failure, owing to non-attainment of reaction equilibrium, solubility of indicators in the oil, and difficulty of separation of phases caused by the emulsifying proclivities of the crude oil.

Puckett[7] has suggested a method of determining the mineral acid content of an oil and extracting it with an equal volume of boiling water and titrating the extract with alkali to a pH of 7. Such a procedure, however, does not necessarily extract all the mineral acidity, so that it is not quantitative. It may of course be used for routine determinations where relative rather than absolute values are of primary importance.

Some acidity measurements have also been made in this laboratory on the aqueous extracts obtained by the salt extraction methods. The values thus obtained have been higher than those on the simple 50-50 water extracts suggested by Puckett, probably owing to the more drastic emulsification procedures that can be used in the former.

It can be seen that the variations on this theme are extremely numerous and the selection of a "proper" method most arbitrary. The dilemma, however, is not which of a number of satisfactory methods to choose, but to find a method that is satisfactory at all. Several experiments were made with various extractants and under different conditions to test the suitability of an extraction method. The results are shown in Table 12, which is self-explanatory. The difficulties encountered in attempting to use these methods may be summarized as follows: Any method that depends upon an extraction of the oil with an aqueous phase has the inherent limitation of the indeterminancy of the extent of contact between the two phases. The degree of dispersion produced, the time of contact, the temperature, the solvents used, and the method of resolution all will profoundly affect the result, and some of these factors are so intangible that reproducibility is foredoomed to be of a low order. The methods typified by the A.S.T.M. procedure, which attempts to produce the neutralization reaction in the oil phase but must have a clear aqueous layer present so that the color change at the endpoint may be detected, have the serious deficiencies attendant upon the marked emulsifying tendencies of crude oil. In

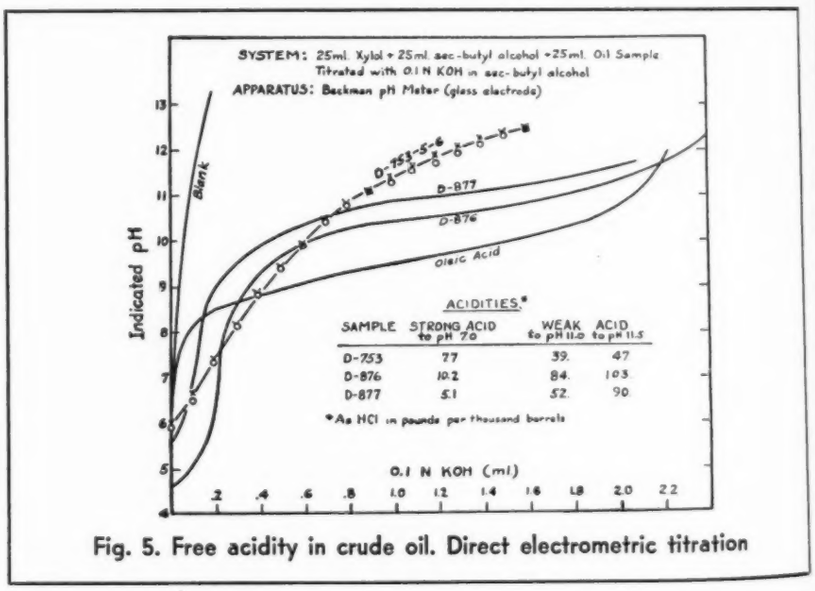
SYSTEM: 25ml. Xylol + 25ml. sec.-butyl alcohol +25ml. Oil Sample
Titrated with 0.1 N KOH in sec.-butyl alcohol
APPARATUS: Beckman pH Meter (glass electrode)
Blank
D-753
D-877
D-876
Oleic Acid
Indicated pH
0.1 N KOH (ml)
ACIDITIES.*
SAMPLE | STRONG ACID to pH 7.0 | WEAK ACID to pH 11.0 | WEAK ACID to pH 11.5
D-753 | 77 | 39. | 47
D-876 | 10.2 | 84. | 103.
D-877 | 5.1 | 52. | 90.
*As HCl in pounds per thousand barrels

Fig. 5. Free acidity in crude oil. Direct electrometric titration

addition it was found that in these methods the endpoints were reached so slowly that the process became exceedingly tedious. The extraction methods were therefore regarded as unsuitable when a complete acidity picture of the oil was desired.

The remaining possibility is that of conducting the titrations in a homogeneous phase. This would preclude the use of indicators but the glass electrode[23†] has provided another method of attack and has shown considerable promise for use in the non-aqueous systems that are required as solvents for crude oil. Various solvents were tested for suitability, to find a combination that satisfies the opposing requisites of high dielectric constant and conductivity, and strong solvent power for the oil. A system that has been tentatively chosen is an equi-volume mixture of xylol and sec-butyl alcohol. The butyl alcohol has good electrical conductivity but oils are incompletely soluble in it, a deficiency that is remedied by addition of the xylol. It was found that with the instrument used, a Beckman glass-electrode pH meter, the titration of organic acids, such as oleic, with KOH in butyl alcohol can be readily followed. The pH values indicated in this system are about 2 or 3 units higher than those which, from the dissociation constants of the acids, might be expected in aqueous solution.

Fig. 5 shows the titration curves obtained when the above procedure is used, the curves passing through the observed points so that the latter are not shown. In evaluating the acidity determinations it is necessary to choose a standard acid of about the same strength as the one that is being measured. In these experiments oleic acid was chosen because it is a reasonably strong organic acid, is readily available, and convenient to use. It was dissolved in the xylol-alcohol solvent and titrated with 0.1 N. KOH in sec-butyl alcohol and the point of inflection of the curve noted. A titration was then made on the mixed solvents in order to obtain the blank correction. It was found that the values from the curves and those obtained by titration of the acid in the conventional manner agreed within 1 percent. A sample of crude oil was then titrated in the mixed solvent and the reading at which the curve reached an indicated pH of 7 chosen as the measure of the strong acidity of the oil. The choice of endpoint for the weak acids will depend upon the range that is of particular interest; the values corresponding to pH of 11.0 and of 11.5 have been taken from the curves and tabulated. The titration curve for sample D-753-5-6 is smooth without inflection, and good reproducibility is indicated by the near-coincidence of the plotted points; the crosses represent the data obtained one day later than the circles. The curves for samples D876 and D877 show by their flat portions some predominating acid species and an appreciable quantity of fairly strong acid titratable below a pH of 7, being 10.2 p.t.b. (expressed as HCl) for D876 and 5.1 for D877. The role of such acidity in increasing the evolvable acid from hydrolyzable salts has already been commented upon in the previous section.

This method for determining the acidity in crude oil is simple, gives excellent reproducibility, and is recommended as the most satisfactory of those proposed for this purpose.

D. Determination of Hydrogen Sulphide Evolution

Although there appears to be considerable difference of opinion among refiners regarding the corrosivity of the hydrogen sulphide evolved during the distillation of a sulphide-bearing crude oil, the extent of this evolution is at least of interest for other reasons, so that a satisfactory laboratory method for its determination is desirable.

Hydrogen sulphide may be determined in the distillate from the acid evolution procedure previously described, as was done by Davis, Jones, and Neilson (loc. cit.). The apparatus used is shown schematically in Fig. 6, which is self-explanatory. The spiral wash bottle was used instead of the conventional A.S.T.M. absorber because the latter did not absorb the hydrogen sulphide completely. The wire heater on the steam inlet prevented condensation that caused violent bumping when the water drops fell into the hot oil. The manometer on the gas line permitted accurate adjustment of the burner, and the vacuum-bottle steam generator supplied a constant supply of steam, the arrangement shown permitting periodic calibration. The set-up was quite satisfactory in operation, permitting close adherence to the prescribed time-temperature schedules.

The method of Davis, et al., for separating the mercaptides from the sulphides by acid was tried but proved to be somewhat uncertain for the samples used, whose sulphide evolution was rather large. A separation based upon an extraction procedure in which the pH of the extractant was high enough to neutralize hydrogen sulphide but insufficiently high to convert the mercaptans to the water-soluble mercaptides was tried. It was found that with a system composed of gasoline, ethyl mercaptan, sodium sulphide, and sodium chloride, quantitative recovery of the sulphide and chloride could be obtained when the pH of the aqueous phase was adjusted to 9.3. Because thymolphthalein begins to show a color change at this point, it was chosen as a suitable indicator. In the experiments with the known system the sulphide content was made equivalent to 24 p.t.b. (as H_2S) and the chloride 15 p.t.b (as NaCl), and the recovery by the procedure outlined was within 2 percent of these values in the presence of about 100 p.t.b. of ethyl mercaptan. The procedure as finally adopted was as follows:

At the end of the distillation procedure, the oil residue is allowed to cool to 400°F. and air is slowly passed through the system for 5 minutes in order to sweep any unabsorbed gases through the absorption system. The receiver contains 25 ml. of normal sodium hydroxide and the absorber 100

†Numbers refer to articles listed at the end of this installment.

TABLE 12

Acidity Determination by Extraction Methods

System: West Branch, Michigan, oil. Lab. sample D-753-5-6

Method	Extractant	Temperature	Endpoint indicator	NaOH req. for neutralization, p.t.b.
A	50S, 50B, 50 Aq.	120	P.T.	17.1
B	50S, 50B, 75 Aq., 25 Ac.	140	P.T.	19.0
C	50S, 75Xy, 75 NaOH (.01N)	120	M.R. (Black Titration)	35.0
D	50S, 75 Xy, 75 Borax (.01N)	120	"	30.0
E	50S, 75 Xy, 75 Borax Buff., $CaCl_2$	120	"	30.5
F	50S, 50 K, 50 Aq.	120	P.T.	56.5
F'	50S, 50 K, 50 Aq.	180	P.T.	48.9
A.S.T.M.	25S, 50 Alc., 50 Aq.	Boiling	P.T.	40.8
A.S.T.M.	25S, 50 Alc., 50 Aq.	Boiling	P.T.	51.6
G	50S, 100K, 50 Aq.	180	P.R.	25.8
G	50S, 100K, 50 Aq.	180	P.R.	24.4
H	50S, 100K, 50 Aq.	180	P.T. (Titr. with Tm B)	13.2

Abbreviations used:
P.T.=phenolphthalein; M.R.=methyl red; P.R.=phenol red; S=sample; Aq=water; B=benzene; Ac=acetone; Tm B=trimethyl benzyl ammonium hydroxide; Xy=xylol; K=kerosene; Alc.=alcohol (95%).

ml. of half-normal sodium hydroxide. After the apparatus has been swept with air, the receiver is removed, quickly stoppered, and shaken so that the hydrogen sulphide is all absorbed in the aqueous layer. The contents of the receiver and absorber are then transferred to a separatory funnel and 0.5 ml. of 1 percent thymolphthalein indicator added to the aqueous phase by means of an elongated medicine dropper. Sulphuric acid (6N) is then added similarly, dropwise, until the blue color has changed to a faint green, the aqueous layer being agitated gently during the process. The funnel is then shaken to effect thorough washing of the oil layer and acid is again added until the very faint greenish endpoint is reached. This will produce a pH of approximately 9.3 in the water layer, which was found to be the proper alkalinity to produce a quantitative separation of the hydrogen sulphide from the mercaptans. It is desirable when first using this procedure to check the alkalinity with a pH meter until the operator becomes familiar with the depth and quality of color necessary for the endpoint stated. When the aqueous layer has settled in the separatory funnel, it is withdrawn into a 250-ml. volumetric flask and the oil washed with 50 ml. of a 0.01 N. borax solution, this extract being combined with the previous one. The volumetric flask is filled to the mark with water, a little gasoline is added and the flask thoroughly shaken in order to cause any residual mercaptans to pass into the gasoline layer. A suitable aliquot part of the water layer is then removed and the sample titrated with silver nitrate according to the Volhard method, care being taken that an excess of silver nitrate is present before the ferric alum indicator is added, as the latter will decompose any soluble sulphide present. This determines the chloride and sulphide together. Another aliquot part is then used to determine the chloride alone, by removing the sulphide with acid as previously described in the section on hydrogen chloride evolution.

In Table 13 are shown the results obtained by this method on the crude oils previously employed. It can be seen that the amount of hydrogen sulphide evolved is virtually constant for all the runs, differences being within experimental error and therefore indicating that none of the variables employed has any appreciable effect on the evolution. In following the experiments in their numerical (which is also their chronological) order, a trend toward better reproducibility will be noted, which is due to improvement in apparatus and technique introduced in the earlier runs.

No extended discussion of the results is necessary as the table is self-explanatory, and the results may be summarized as follows:

1. Steam causes no increase in hydrogen sulphide evolution over distillation without steam. (Experiments 8 and 9).

2. Removal of centrifugeable material has no effect. (Experiments 10 and 11).

3. Removal of water-extractible substances by thorough water-washing has no effect. (Experiments 12 and 18).

4. The presence of hydrolyzable and non-hydrolyzable salts does not influence the evolution. (Experiments 14 to 21.)

The general conclusion to be drawn from these experiments is that the hydrogen sulphide evolved upon distillation is virtually unaffected by any of the conventional prefining operations to which crude oils are subjected, and acidic materials and salts exert no appreciable influence on the evolution. It is only in oils in which a considerable quantity of free hydrogen sulphide and the lower mercaptans are present that conventional prefining operations will have a material effect, as the hydrogen sulphide evolved by distillation is the product of decomposition of organic sulphur compounds present in the oil.

Acknowledgments: Most of the experimental work reported herein was done by Messrs. W. F. Eberz and I. L. Cooley of the Petreco Research Staff, whose contributions are gratefully acknowledged. The authors also wish to acknowledge the valuable assistance of Messrs. Suthard and Niswander of the Petreco Research Staff in the experimental work here reported.

EDITOR'S NOTE: Reprints of this series can be obtained from The Petro-

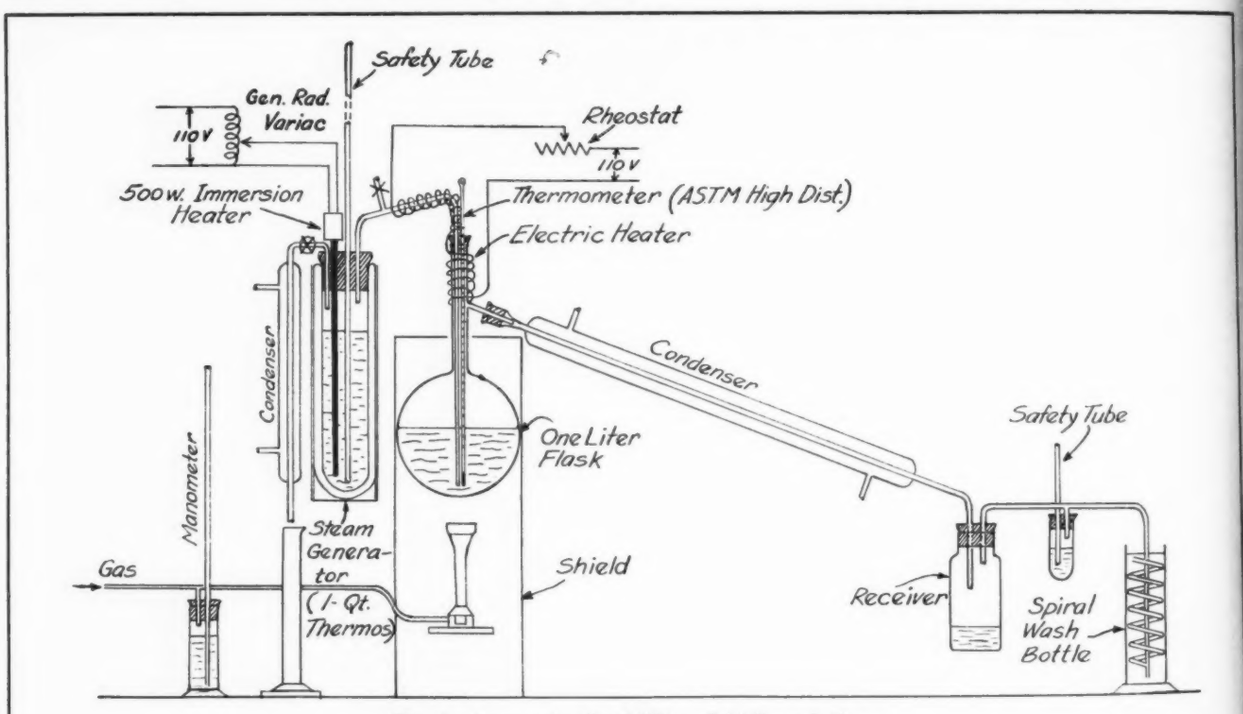

Fig. 6. Apparatus for HCl and H_2S evolution

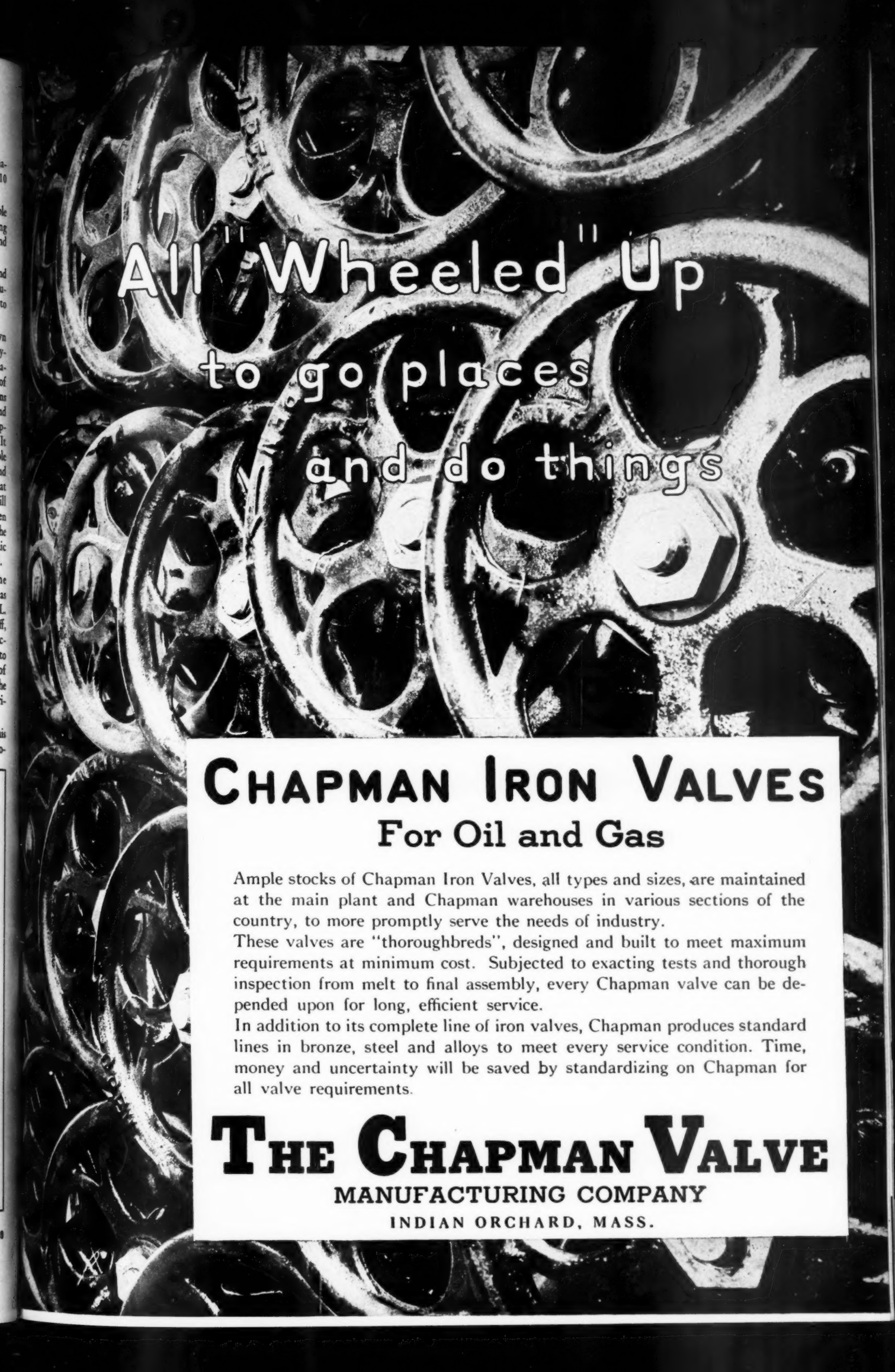

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TABLE 13

Hydrogen Sulphide Evolution

Exp. no.	Sample	Treatment	Salt added — Addition	Salt added — Form	Evolved H_2S, p.t.b.
8	D876	None	None		886
9	D876	No steam	None		890
10	D876	Centrifuged	None		1040
11	D876	Centrifuged, no steam	None		952
12	D876	Water-washed	None		857
18	D876	Water-washed	None		900
14	D876	Water-washed	NaCl	Grd.	903
15	D876	Water-washed	$CaCl_2$	Grd.	910
16	D876	Water-washed	$MgCl_2$	Grd.	907
21	D876	Water-washed	$MgCl_2$	Sol'n.	944
17	D876	Water-washed	$MgCl_2$+NaCl	Grd.	915
19	D876	Water-washed	$MgCl_2$+$CaCl_2$	Grd.	910
13	D877	None	None		926
		Grand average			918
		Average deviation			29

leum Rectifying Company of California, 530 West Sixth Street, Los Angeles, California.

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Disposal of Oil-Field Brines

As a feature of its study of the disposal of oil-field brines, the U. S. Bureau of Mines has published a report on the construction of seven typical oil-field brine-conditioning plants and their operation in preparing brines for subsurface disposal. The investigation is being conducted in coöperation with the Kansas State Board of Health. Oil-field brines are frequently a troublesome operating problem in the production of petroleum and sometimes constitute a source of pollution of domestic water supplies.

One of the major problems in the underground disposal of oil-field brines is the clogging of the subsurface formation in the disposal well by suspended matter in the brines. Pretreatment of brines and subsequent subsurface disposal remain in the experimental stages owing to technical and economic problems involved. Consequently numerous types of brine-conditioning systems and methods of brine treatment attaining various degrees of success have been developed.

The report discusses in detail the construction and operation of seven typical oil-field brine-conditioning and disposal systems. The data include the chemical and corrosive characteristics of brines before, during, and after conditioning in various types of systems for subsurface injection. The similarity of the treating methods and the processing equipment used in the conditioning of brines for subsurface disposal and water-flood projects are discussed. The so-called closed, open, and semi-closed types of systems that are used to condition the sour (hydrogen sulphide containing) brine, as well as the more stable brines containing iron in solution, are discussed. The brines prepared for subsurface injection by the conditioning systems were produced with oil from four formations: Arbuckle (Siliceous) limestone of Cambro-Ordovician age, Kansas City limestone and Burbank sand of Pennsylvanian age, and "Wilcox" sand of Ordovician age. The brines from these formations, especially that produced from the Arbuckle limestone, present specific problems in brine conditioning for subsurface disposal.

The report contains complete descriptions and histories of the injection wells.

The cost data supplied by several of the operators are included to indicate the cost of processing brine for subsurface disposal by several experimental brine-conditioning systems.

The factors of basic importance in the selection of type, installation, and operation of brine-conditioning systems are pointed out.

Several flow diagrams, photographs, and detailed tables are included, which should assist engineers in developing further improvements in the design and technique of operation of oil-field brine-conditioning systems.

These studies, by Sam S. Taylor, C. J. Wilhelm, and W. C. Holliman, have been published as Report of Investigations 3434, "Typical Oil-field Brine-Conditioning Systems: Preparing Brine for Subsurface Injection." Copies are available without charge upon request from the Bureau of Mines, Washington, D. C.

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Figure 108—Standard Cast Iron Flange Union

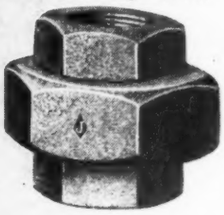

Figure 334—Extra Heavy Bronze Ground Joint Union

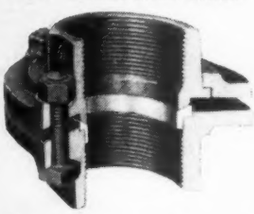

Figure 1847—Three-Piece Standard Malleable Ground Joint Union

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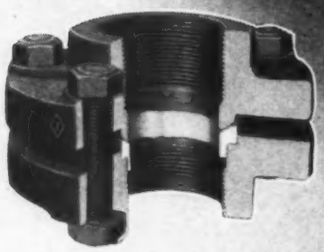

Figure 1896—Extra Heavy Malleable Hydraulic Ground Joint Union

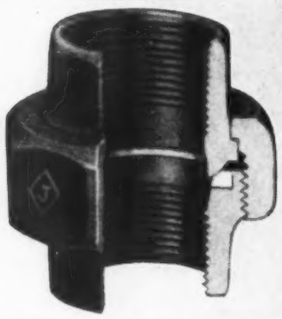

Figure 101-A—Jarco Heavy Malleable Ground Joint Union

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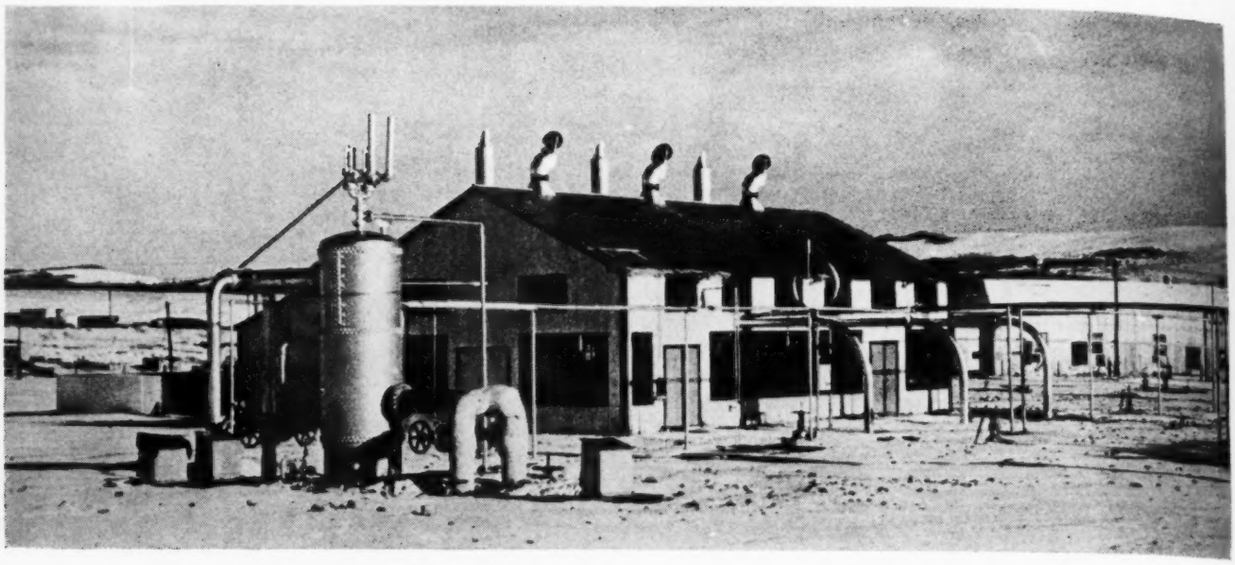


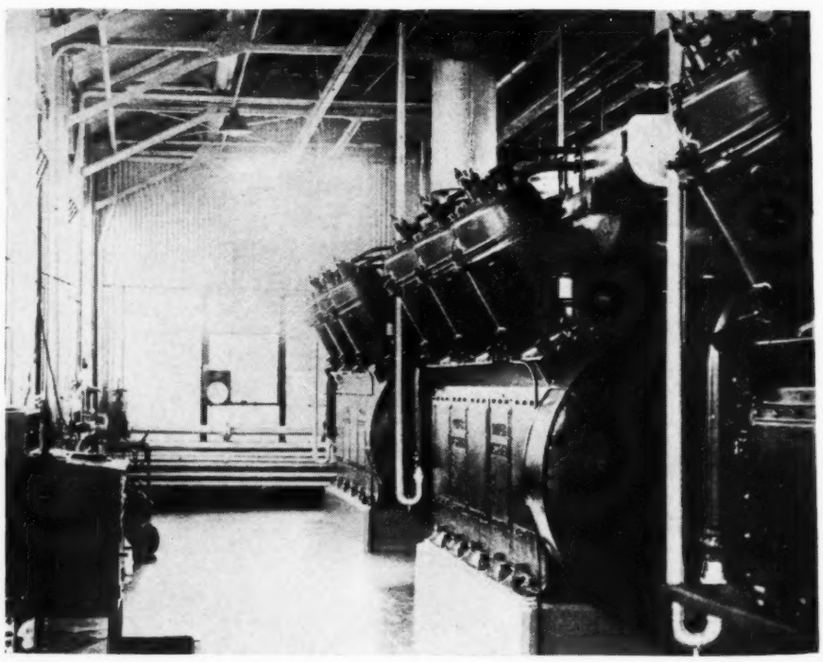
General view of Royalite Oil Company compressor station in Turner Valley, Canada

Compressor Station Design Facilitates Installation of Additional Units to Increase Capacity

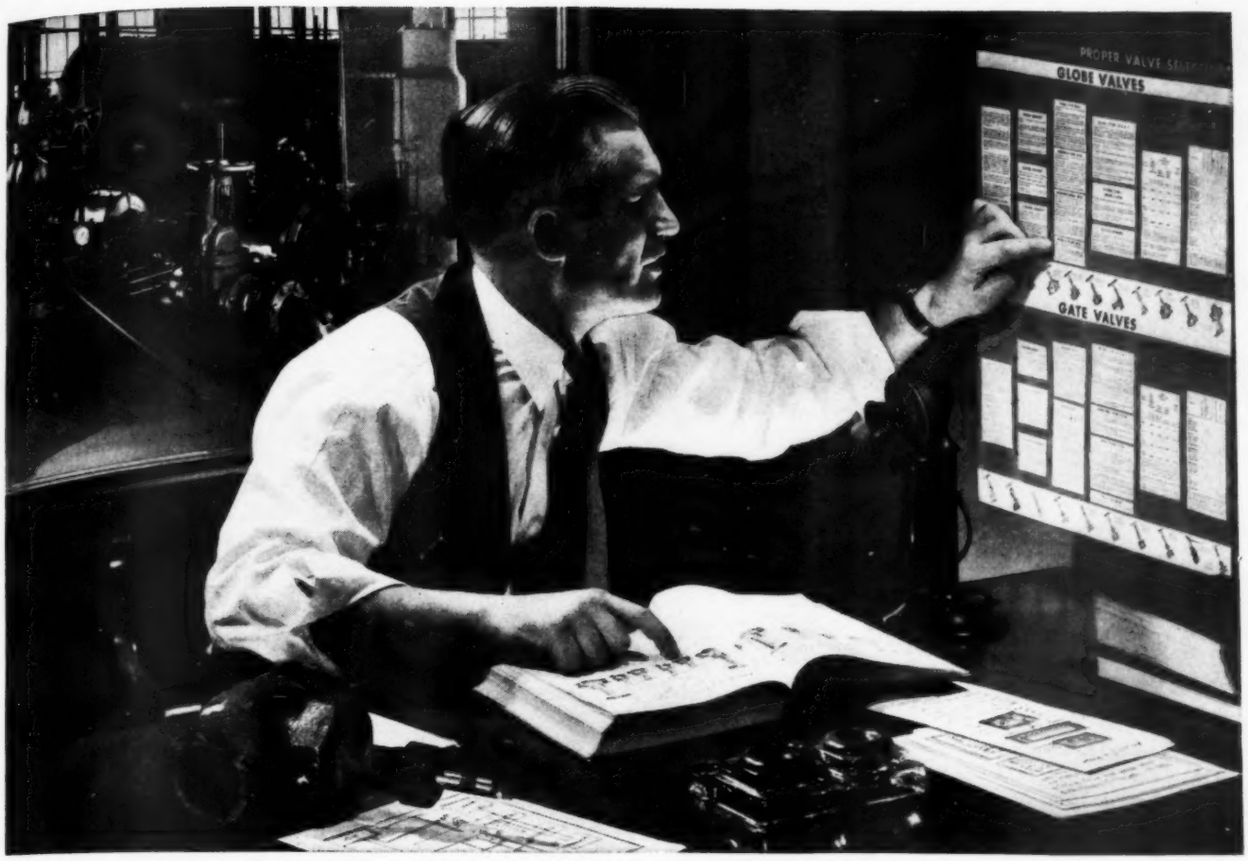
Building and headers of Turner Valley plant can be extended easily. Transportation of units constituted a special problem

By FRANK H. LOVE
Managing Editor

FOR 13 YEARS gas from the limestone formation in the Turner Valley field, 30 miles southwest of Calgary, Alberta, Canada, has been distributed under natural pressure by the Canadian Western Natural Gas, Light, Heat and Power Company to the towns on its 180 miles of main line from Calgary to Macleod, Lethbridge, and Bow Island. The decline in field pressure necessitated installation of compressors in 1938 to deliver the gas at the pressure required to meet the peak loads of winter. The Royalite Oil Company, Ltd., who supply the gas, therefore designed and constructed a compressor plant in the



Gas-engine-driven 600-hp., V-angle-type, 2-cycle, 6-cylinder compressor units were installed—Each unit has a rated capacity of 27,000,000 cu. ft. per day



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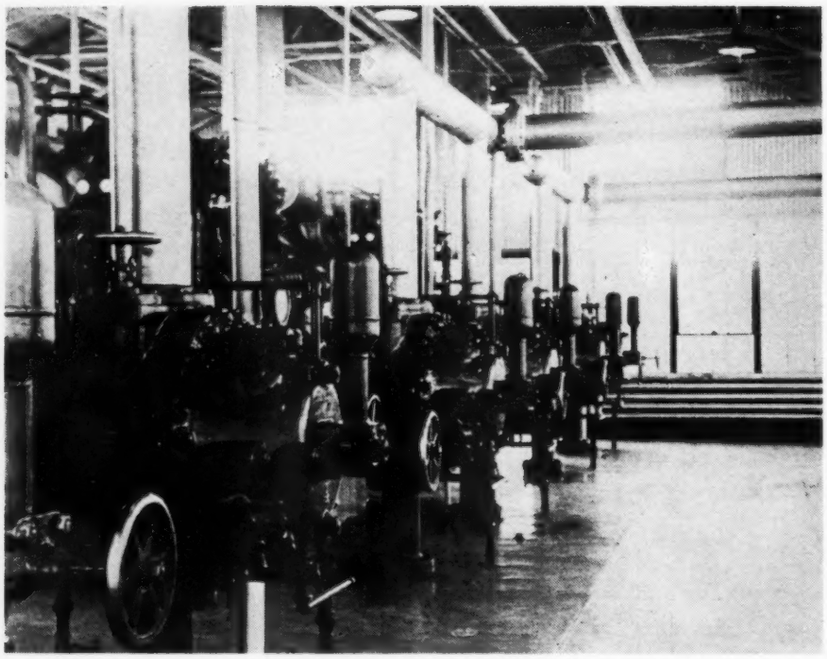


Each unit is equipped with two 12-in. by 14-in. compressor cylinders

summer of 1938. The plant was placed in operation in October and has been in continuous operation since the middle of November. Gas-engine-driven 600-hp. compressors were selected, this being the first installation of this V-angle-type 2-cycle unit in the 6-cylinder size. The power cylinders are 14 in. by 14 in. and the units are equipped with two 12-in. by 14-in. compressor cylinders. Their rated capacity is 27,000,000 cu. ft. per day each at 300 r.p.m. from 250-lb. suction to 325-lb. discharge pressure. Their equipment includes silencers, hydraulic governors, and magnetos.

Zeolite-treated water containing less than one grain hardness per gallon is used in the cooling system. This water runs by gravity through the engines from a 10,000-bbl. tank situated on a nearby hill to a 500-bbl. hot well, to be picked-up by centrifugal pump and returned through heat exchangers to the elevated tank. River water is used as the cooling medium in the heat exchangers. Two air-cooled compressors deliver air for starting to six 20-in. by 10-ft. receivers. The generous size of the compressor bypasses allows the engines to roll easily on 150-lb. air pressure.

The units were shipped completely assembled except flywheel and compressor cylinders, weighing approximately 40 tons each. They were transported from railhead 25 miles away over gravelled roads on a specially designed bed suspended between two tractor wagons. All small bridges had to be reinforced as the tractor train weighed more than 60 tons, and paved highway crossings were covered with planks to prevent damage to the surface.

Three units have been installed in a building of modern design employing the continuous-window principle to give maximum light. Both the building and headers were designed for easy extension to accommodate a total of ten similar machines. Provision has been made for laying intermediate headers and intercoolers when the field pressure drops to a point at which two-stage compression becomes necessary. Gathering lines bring the wet gas from wells both north and south of the plant. Continuity in service being important, both the 24-in. suction and 16-in. discharge headers are divided by gate valves into two portions so that either side can be operated while the other side is shut-down for repairs. The chances of trouble developing were minimized by adhering to A.S.A. standards for all pipework, and by using chill rings in all butt joints and reinforcing all connections to the headers. Electric shielded-arc welding was employed throughout. After compression the gas passes through shell-and-tube coolers using water, then through separators that remove any condensate before the gas enters the oil absorption towers at 320-lb. pressure. The residue gas from the absorbers passes to the scrubbing plant where the hydrogen sulphide content is reduced to 5 grains per 100 cu. ft. by the Koppers Seabord process before the gas enters the lines of the Canadian Western Natural Gas, Light, Heat and Power Company.

The plant was designed and constructed by the regular staff of the Royalite Oil Company under the supervision of the field superintendent, R. E. Trammell, and plant superintendent, J. F. MacKay.

Asphalts from Oregon Basin, Wyoming, Crude Oil

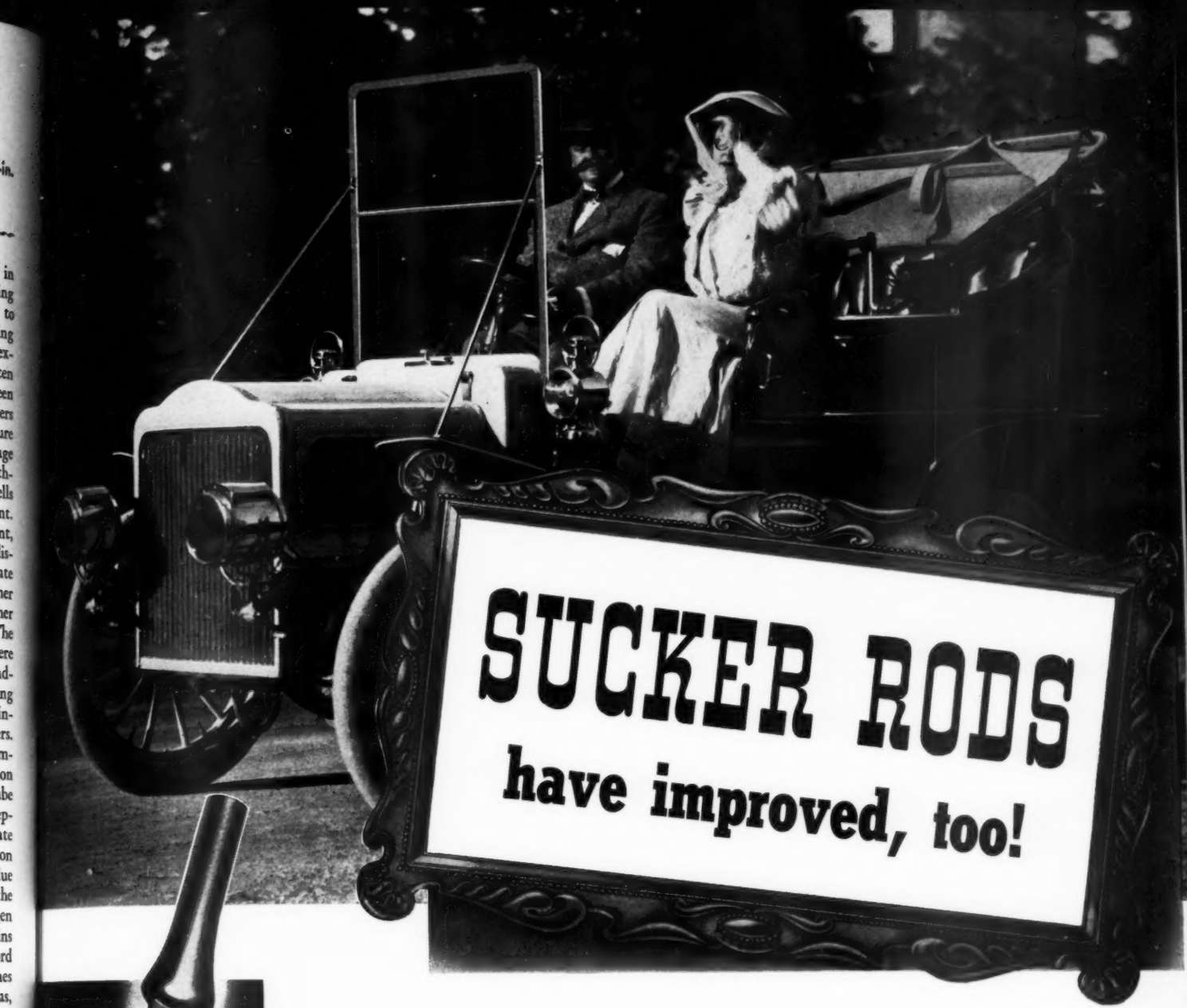
THE characteristics of a series of penetration asphalts prepared from Oregon Basin, Wyoming, crude oil are described in a report published by the U. S. Bureau of Mines. The Petroleum Experiment Station of the Bureau of Mines at Laramie, Wyoming, has for some time been making a study of the more economical utilization of the high-sulphur, asphaltic crude oils of Wyoming that are difficult to refine by present methods into high-octane motor fuels, burning oils, and lubricants. As these crude oils are used chiefly for the manufacture of asphalt and road oil, the immediate purpose of this report is a description of a laboratory method that was developed to study their asphaltic fractions and to give the results of a study made of the asphaltic fraction of Oregon Basin, Wyoming, crude oil.

The asphaltic fraction of this crude oil was examined by the preparation and determination of the properties of a series of six asphalts representing different percentages of the crude oil. The properties of the asphalts, which were determined by common asphalt tests, are reported in graphic and tabular form.

The glass distilling apparatus used in the reduction of asphaltic crude oil to asphalt is described.

The rate of change in consistency with change of temperature, or the temperature susceptibility, of these asphalts was determined by published formulas and the values compared with the temperature susceptibility reported for similar asphalts from other typical crude oils. According to these data the Oregon Basin asphalts have temperature susceptibility characteristics similar to those reported for commercial asphalts manufactured from Mid-Continent crude oils.

Copies of Report of Investigations 3435, Some Asphalts From Oregon Basin, Wyoming, Crude Oil, by K. E. Stanfield, are available without charge.



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Arc of Belt Contact on Small Pulley or Sheave

A PETROLEUM ENGINEER EXCLUSIVE FEATURE

By W. F. SCHAPHORST

THE accompanying chart indicates the arc of belt contact, in degrees, on any small pulley or sheave of any open belt drive under most refinery and oil production working conditions. It is based on a formula that was developed 14 years ago—a formula that has since been frequently used by belt transmission engineers.

Referring to the sketch above the chart, "A" is the distance between shaft centers in in., and line "A" of the chart shows such distances from 20 to 400 in.

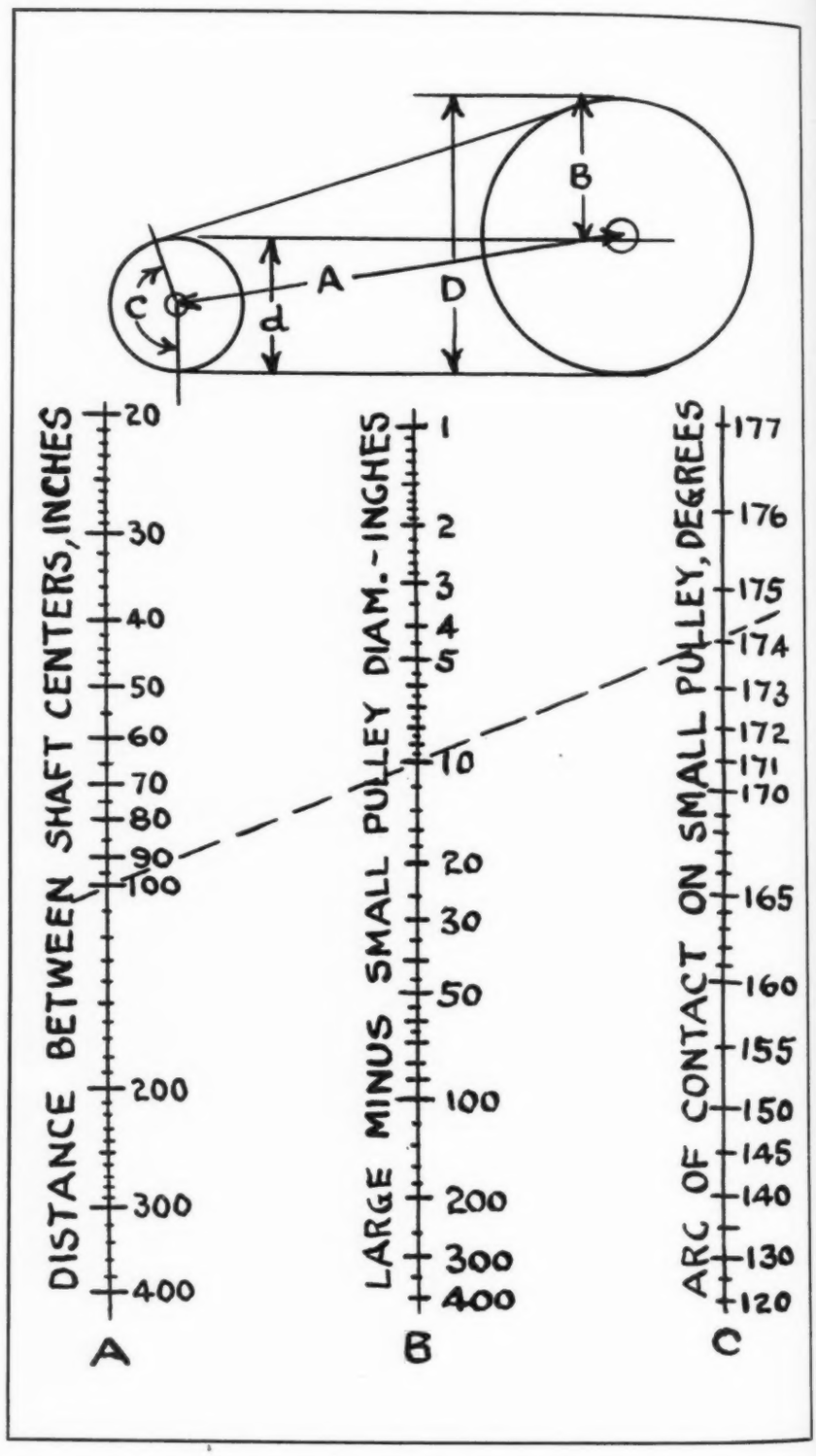
"B" in both the sketch and chart represents the large pulley diameter minus the small pulley diameter, also in in.

A straight line through the known value in "A", and the known value in "B" intersects the straight line "C", and indicates the arc of contact on the small pulley or sheave "C", as indicated in the sketch.

For example, the dotted line drawn across the chart shows that if the distance between shaft centers is 100 in. (column A), and the difference in pulley diameters is 10 in. (column B), the arc of contact is slightly more than 174 deg.

Should you wish to check the figures in longhand, it can be done in this way: Multiply the difference in diameters in in. by 58; divide that product by the distance between shaft centers in in.; and then subtract the quotient from 180. The result is the arc of contact on the small pulley or sheave in degrees.

This result is not absolutely correct, but it is a sufficiently close approximation for all ordinary belt drive calculations. It is applicable to V-belts as well as to flat belts. For V-belts use the "pitch diameters" of the sheaves.



Quiz?

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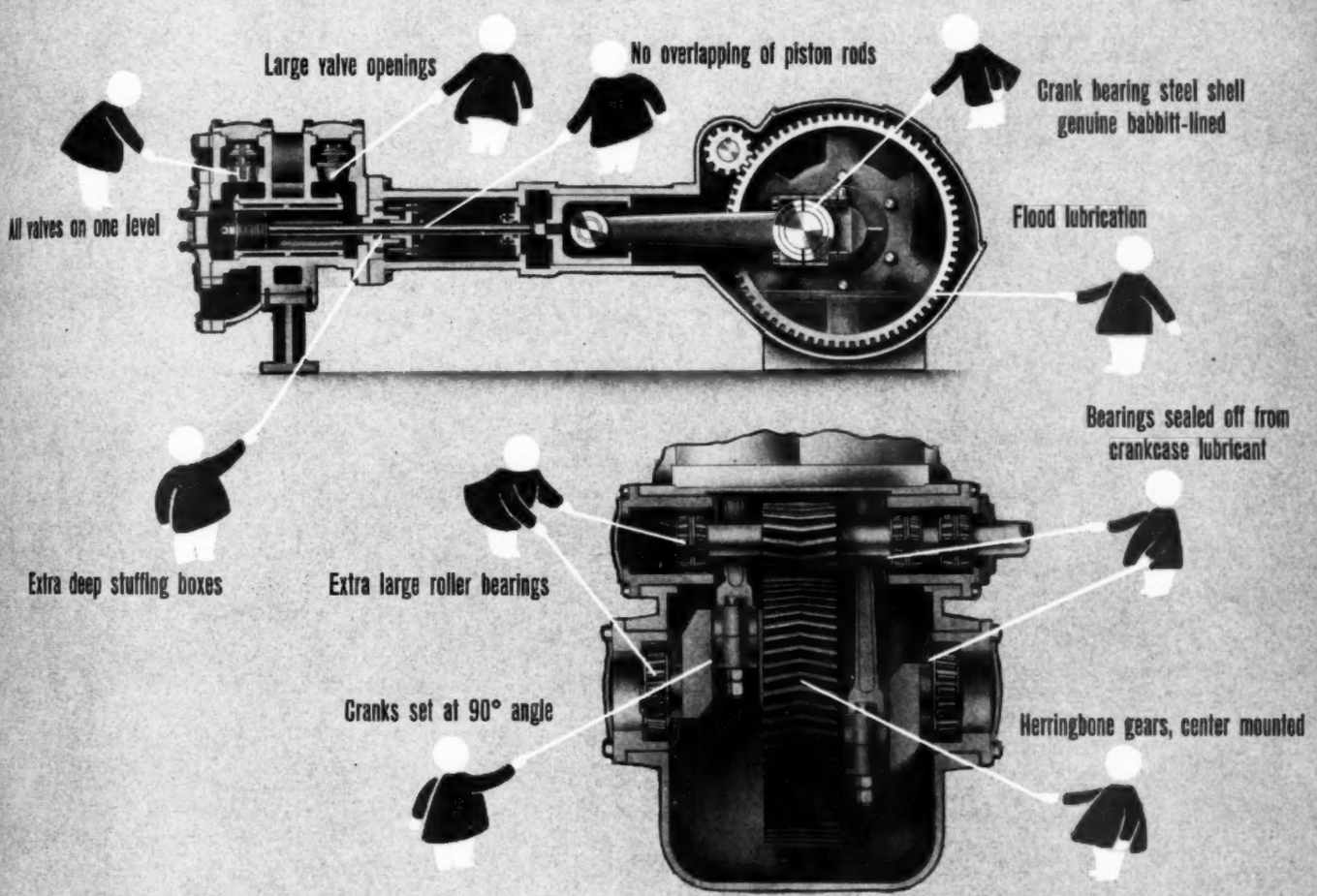
ANSWER: Supremacy of design — based not on any single feature but on a *combination* of features developed through unmatched experience and specialized knowledge of pipeline requirements. For example: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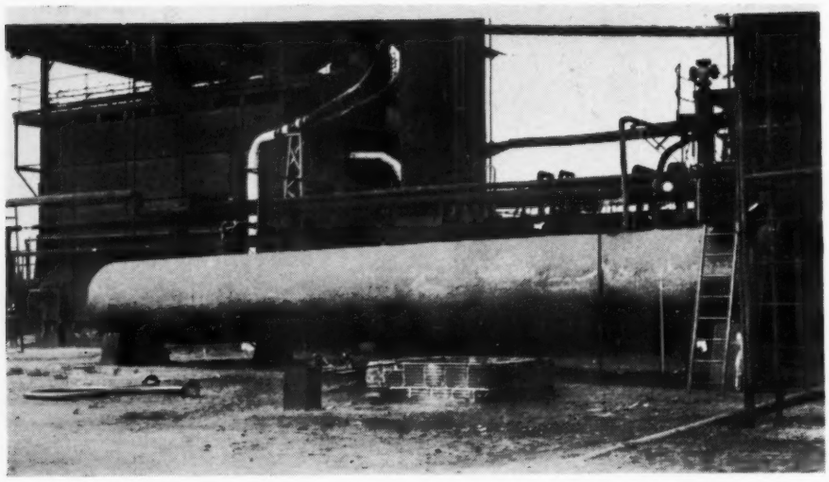


Drum used in removing salt from crude oil

Water-oil mixture warmed in heat exchanger by heat from column cut

Salt-Removal Drum is Economical Method of Reducing Corrosion

By J. C. ALBRIGHT

TO remove salt and thereby prevent corrosion of equipment, all crude oil produced in most of the oil fields of Michigan must be treated before or during refining. The oil produced from the Crystal field during the declining stage was particularly damaging when reduced crude oil was used as a charging stock for cracking. The Naph-Sol Refining Company, which has processed a large quantity of oil produced in Michigan, has devised a method of removing enough salt from the oil that corrosion of equipment is virtually eliminated.

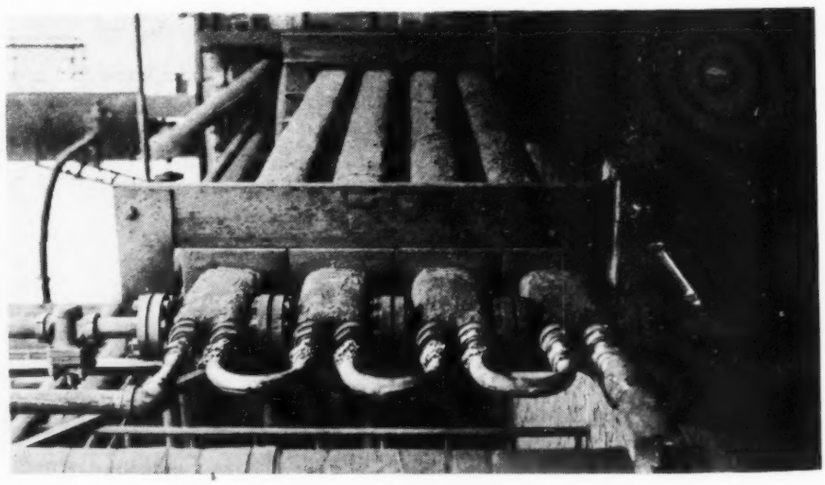
The quantity of salt present in the oil has been found to be variable but always sufficient to damage various parts of the cracking plant. It has been observed that if the concentration of salt is reduced to about 15 lb. per 1000 bbl. corrosion is greatly reduced. When the cracking plant was first equipped to process reduced crude oil a salt-removal drum was installed between the charge pump and the main fractionating column. For effective salt removal the oil was heated by a heat exchanger. For several months the heat was obtained from fuel oil bottoms but the viscosity interfered with maintenance of constant flow and hence of constant temperature.

When improved conditions warranted a greater throughput, the charge was heated by the column cut that was used to heat the stabilizer column reboilers.

The cut from the column flows through the heat exchanger at the tower pressure of about 70 lb. per sq. in. and thence to the cooling coils. The reduction of temperature increases the viscosity and retards the flow, so a pump is used as required, to return the cut to the fractionating column to control fractionation. By returning this cut to the fractionating column the products from the column may be "gapped" instead of overlapped. The pump is manually controlled, but is adjusted to the amount of oil charged and the temperature required for effective removal of salt.

Water is mixed with the oil by injecting a measured amount of cold water at the intake of the charge pump to dissolve the suspended salt crystals. Heating of the mixture of oil and water breaks the film of oil surrounding the salt crystals and accelerates the reduction of the charge. The operation of the mixing, heating, and settling units becomes almost automatic once the proper balance has been established. The quantity of water added to the charging stock varies with the stock, but seldom exceeds 10 percent of the quantity of oil. A meter is installed on the water line at the charge pump.

The cost of operation of the unit is little if any greater than it was when fuel oil bottoms were used to heat the charge. The cost of operation of the pump is more than offset by the saving resulting from more efficient removal of salt and consequent increased life of equipment. After the heating medium was changed the plant was operated for 51 days and no corrosion was observed.



Heat exchanger employed to heat the oil

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Lake Barre field, Terrebonne Parish

Growth of Louisiana's Oil Industry Has Been Rapid

Since the first field was discovered in 1901 nearly a billion bbl. of oil has been produced and the state is definitely increasing in importance with respect to production and reserves

By H. LEE FLOOD
Associate Editor

THE history of oil in Louisiana is truly a twentieth century chronicle for only after the turn of the century was oil produced in commercial quantity in the state. Linked together geographically, Louisiana and Texas share also in the date of discovery of oil production. The whole world in 1901 heard of Spindletop in Jefferson County, Texas, when that prolific field was discovered. Few people outside Louisiana knew, or know today, that at the time of the Spindletop discovery Louisiana was registering its first production in the Jennings field, Acadia Parish, only a short distance east.

First Louisiana Field

The Jennings field was discovered in August, 1901. Considering the tremendous importance in later years of salt domes as guides to the presence of oil, it is significant that this first field is situated on the Jennings salt dome, also referred to as the Evangeline dome.

The discovery well at Jennings produced oil at a depth of 1882 ft., from sands of upper Miocene age. Offsets to the discovery and other wells hurriedly drilled increased the production to a maximum in 1906 when more than 9,000,000 bbl. of oil was recovered. After 1906, production from the Jennings field declined more or less steadily until 1937. Development of the southwest flank of the dome followed the successful completion of Superior Oil Company's No. 1 Leckelt in September, 1936. The 47 wells drilled in 1937 increased production in the Jennings field from 806,000 bbl. in 1936 to almost 3,000,000 bbl. in 1937. Further development on the dome-flanks during 1938 resulted in Jennings, the oldest field in the state, leading all other southern Louisiana fields in production. During 1939 the daily production from Jennings has exceeded 24,000 bbl. If this rate is maintained for the rest of the year, Jennings will probably lead the Louisiana Gulf Coast for the second successive year. This is truly a remarkable record, considered in its entirety. Jennings, first to produce oil in 1901, again takes the lead in its 38th year of life and shows the oil industry the possibilities that accompany deeper drilling and further prospecting on the flanks in old known, even unproved, areas.

Louisiana Production History

Activity in the Louisiana oil industry has been so great during the last 19 years that it has become necessary to treat the two parts of the state separately in reports and records.

Considering the state as a whole, however, for the purpose of discussing its history as one of the important oil states in the nation, it is interesting to note the manner in which North and South Louisiana oil production has tended to balance. The more interesting points in Louisiana's oil history may be outlined as follows:

1901—First oil produced in commercial quantities in the Jennings field, South Louisiana.

1906—(a) Jennings field produced slightly more than 9,000,000 bbl. to create first Louisiana production peak. (b) North Louisiana obtained first commercial production at Caddo Lake in Caddo Parish.

1910—North Louisiana production exceeded that of South Louisiana for

the first time. Production of the two areas: North, 5,100,000 bbl.; South, 1,753,000 bbl. The increase in North Louisiana production from approximately 1,000,000 bbl. in 1909 was due entirely to increased activity in Caddo Parish, the only producing area developed in the northern part of the state until 1914 when oil in commercial quantity was found in DeSoto and Red River parishes.

Producing fields in South Louisiana in 1910 and their production were as follows:

Date of first commercial production	*Field*	*Parish*	*1910 production (nearest 1000 bbl.)*
July, 1905	Anse La Butte	St. Martin	45,000
August, 1901	Jennings	Acadia	1,625,000
June, 1910	Vinton	Calcasieu	28,000
January, 1903	Welsh	Jefferson Davis	55,000
			1,753,000

1915—Second Louisiana production peak (first for North Louisiana). Caddo, De Soto, Red River, and Sabine parishes in Northern Louisiana produced a little more than 15,000,000 bbl.

Production from the four fields listed as active in 1910 had increased to give South Louisiana a total of 3,100,000 bbl. for the year.

1920—North Louisiana established the first big production in the state's history. Increasing from slightly less than 15,000,000 bbl. in 1919 to nearly 34,000,000 bbl. in 1920, North Louisiana's production was greater in 1920 than it has been in any other year to and including 1938.

Discovered in May, 1919, the Homer field in Claiborne Parish was responsible for the large production in 1920. An active drilling campaign resulted in a production of 22,000,000 bbl. from Homer alone in that year. Incidentally, 1920 was the peak year for the Homer field. Production in the field declined steadily to 907,000 bbl. in 1937. In 1938, the first slight gain was registered, production from the field being 950,000 bbl.

South Louisiana in 1920 was still comparatively quiet. Total production for the year, still principally from the four fields listed as active in 1911, was slightly less than 2,000,000 bbl.

1922—North Louisiana again produced a near-record total for the district, almost duplicating the 1920 production figure. Again a Claiborne Parish field was the contributing factor but instead of Homer, it was the newly discovered Haynesville field 5 miles northeast of Homer. Again, as in 1920, flush production from a single field served to increase the total.

1923-1931 — This nine-year period of Louisiana's oil history was characterized by a gradual transition in the relative importance of production from the two Louisiana districts. North Louisiana declined in annual production as South Louisiana registered a gradual increase. Production (in bbl.) at the beginning and end of this period is indicated as follows:

	North Louisiana	*South Louisiana*	*Total Louisiana*
1923	22,500,000	2,500,000	25,000,000
1931	12,500,000	9,500,000	21,500,000

The production decline in the northern part of the state occurred in spite of the discovery of oil in the Cotton Valley field in 1924 and peak production in 1925 of 3,340,000 bbl. Despite discovery of new zones, Cotton Valley's production declined rapidly until 1937 when production from the entire field was about 600,000 bbl. Production in 1938 including that from the lower Marine zone discovered during the year again exceeded 3,300,000 bbl.

Urania field in La Salle Parish served to stem the decline in production for one year, 1926.

The increase in production in South Louisiana resulted from a more or less steady increase in the total number of fields in the district. Many of these new discoveries can be attributed to the geophysical exploration that was being conducted during this period for the first time. During 1924 to 1931, inclusive, 20 new fields in 9 parishes were discovered.

1932—South Louisiana exceeded North Louisiana in annual production for the first time since 1909. This year marked the beginning of South Louisiana's spectacular increase in production to almost 67,000,000 bbl. in 1938.

1936—Ending a 13-year period of production decline, North Louisiana produced slightly less than 26,800,000 bbl. in 1936. The increase from 7,800,000 bbl. produced in 1935 was due almost entirely to the first large oil production from the Rodessa field in Caddo Parish.

Louisiana's Importance As An Oil State

Important though Louisiana's contribution of oil has been to the wealth of the nation during all the twentieth century, the real significance lies in the fact that the state is definitely increasing in importance as far as production and discovery of new reserves is concerned.

Louisiana as a whole has produced 919,000,000—nearly a billion—bbl. of oil since the Jennings field was discovered in 1901. More than 10 percent of this volume was produced in 1938.

Louisiana's 1938 oil production of almost 95,000,000 bbl. was equivalent to approximately one-fifth of Texas'; to nearly two-fifths of California's; to more than one-half of Oklahoma's, and to almost twice that of Kansas.

Although this review has been concerned only with oil production, Louisiana's importance as a gas-producing state has not been overlooked. On the contrary, because Louisiana has gained prominence principally because of the vast gas reserves of the Monroe, Richland, Elm Grove, and Rodessa fields in northern Louisiana, the purpose of this review has been to emphasize only the steadier, more important development of the oil fields of the state.

Louisiana's Future

So many different elements enter into an evaluation of Louisiana's future oil and gas development that it is difficult to weigh them properly. Deeper drilling, marine drilling offshore in the Gulf of Mexico, pressure maintenance, recycling, continued and more efficient use of geophysical methods, all are playing their part in creating more interest and in developing more potentialities in Louisiana than in any other oil-producing state at the present time.

Of greater importance than is recognized generally is the possibility of extensive production in the Sparta-Wilcox series underlying central Louisiana. Development in this area would close the gap between the northern and southern district and insure production from virtually the entire state. Production has been obtained in both the Sparta and the Wilcox zones but the true magnitude of the possibilities of these zones underlying more than 9000 acres will not be known until further testing has been done. Interest in the Sparta followed its "discovery" (in Louisiana) in the Ville Platte field, Evangeline Parish, in September, 1937. The Wilcox produced oil for the first time in Louisiana in January, 1939, in the Eola field, southwestern Avoyelles Parish.

P 991.111.35
P 991.111.41

Summary of Oil Fields Discovered and Developed in Louisiana

To January 1, 1939, a total of 113 fields had been discovered—Potentialities of state appear to be great

By RALPH H. KING

DURING 1938 there were 21 new oil fields discovered in the State of Louisiana, 18 in South Louisiana and 3 in North Louisiana. The state's total number of oil and gas fields, as of January 1, 1939, was 113.

To make available a brief historical record of all fields the following summaries are presented:

SOUTH LOUISIANA

Abbeville, Vermilion Parish, was discovered in 1937, on a geophysical prospect mapped in 1929. There are five wells producing oil from depths of 6400 and 7700 ft.

Anse La Butte, St. Martin Parish, was discovered in 1905. More than 100 wells have been drilled but only nine now produce. All the oil has been obtained from several shallow sands.

Bancroft, Beauregard Parish, was discovered in May, 1938. The ten wells in the field produce from a 7350-ft. sand.

Bateman Lake, St. Mary Parish, was discovered in 1937, on a geophysical prospect mapped in 1929. Two wells produce oil from a sand at a depth of 10,900 ft.

Baton Rouge, East Baton Rouge Parish, was discovered in March, 1938. Six wells produce oil from a sand at a depth of 6475 ft.

Bay Baptiste, Terrebonne Parish, was discovered in August, 1938. One well produces oil from a depth of 11,175 ft.

Bay Coon Road. See Bay St. Elaine.

Bay Junop structure, Terrebonne Parish, has not yet produced oil.

Bay Marchand structure, Lafourche Parish, has not yet produced oil.

Bay St. Elaine, Terrebonne Parish, produced gas in 1929, oil in 1937, on a geophysical prospect mapped in 1928. Three wells produce oil from a depth of 5500 ft.

Bayou Bleu, Iberville Parish, was discovered in 1929 and abandoned in 1932. In 1936 oil was discovered in a sand at a depth of 1770 ft. and the well is now producing. One of the six wells drilled in 1938 is also producing.

Bayou Bouillon, St. Martin Parish, was discovered in 1902, first produced oil commercially in 1928, and was abandoned in 1931. Activity was renewed in 1936, but results have been unencouraging.

Bayou Choctaw. See Choctaw.

Bayou Des Allemands. See Des Allemands.

Bayou La Rampe. See Bayou Bouillon.

Bayou Mallet, Acadia Parish, was discovered in 1936, on a geophysical prospect mapped in 1934 and 1935. Four wells produce from three sands at depths between 6380 and 7200 ft.

Belle Helene. See Darrow.

Big Lake, Cameron Parish, was discovered in 1935, on a geophysical prospect mapped that year. Three wells produce from sands at depths of 8300 ft. and 9050 ft.

Black Bayou, Cameron Parish, was discovered in 1929, on a geophysical prospect mapped in 1927. There are 22 wells producing from three sands at depths of 3800 ft., 5200 ft., and 6600 ft.

Bosco, Acadia and St. Landry parishes, was discovered in 1934, on a geophysical prospect mapped in 1932. There are 56 wells producing oil from at least six different sands, at depths between 7800 and 9100 ft.

Caillou Island, Terrebonne Parish, entirely covered by shallow water, was discovered in 1930, on a geophysical prospect mapped in 1928. There are 38 wells producing oil from several sands at depths between 3240 ft. and 6840 ft.

Calcasieu Lake structure, Cameron Parish, has as yet produced no oil.

Cameron Meadows, Cameron Parish, was discovered in 1931, gas seepage having led to geophysical mapping of the prospect. There are 34 wells producing from various sands at depths between 3200 ft. and 5200 ft.

Chacahoula, Lafourche Parish, yielded oil on the flank of the dome in September, 1938. Two wells are producing from a depth of 7250 ft.

Chalkley, Cameron Parish, was discovered in November, 1938, and two wells produce from a depth of 8550 ft.

Charenton, St. Mary Parish, was discovered in 1936, on a geophysical prospect mapped in 1935. There are 35 wells producing oil from several sands at various depths between 1800 ft. and 7200 ft.

Cheneyville, Rapides Parish, was discovered in 1935, on a geophysical prospect mapped in 1933. Seven wells produce oil from a sand at a depth of 5700 ft.

Choctaw, Iberville Parish, was discovered in 1931, on a geophysical prospect mapped in 1927. Eleven wells produce oil from several sands at depths between 2400 ft. and 5400 ft.

Cockrell. See Lake Washington.

Convent, St. James Parish, was discovered in July, 1938. One well is producing oil from a depth of 6350 ft.

Creole, Cameron Parish, was discovered in March, 1938, in the Gulf of Mexico. Five wells produce oil from a depth of 5150 ft.

Darrow, Ascension Parish, was discovered in 1932, on a geophysical prospect mapped in 1927. Twelve wells produce oil from sands at various depths between 4000 ft. and 7000 ft.

Delarge, Terrebonne Parish, was discovered in June, 1938. One well is producing from a depth of 13,250 ft.

Des Allemands, St. Charles Parish, was discovered in 1937, on a geophysical prospect mapped in 1936. Three wells produce oil at a depth of 6850 ft.

Dog Lake, Terrebonne Parish, was discovered in 1929, on a geophysical prospect mapped in 1928. It lies in a tideland marsh. Six wells produce oil from a depth of 6800 to 7100 ft.

East Hackberry, Cameron Parish, was discovered in 1937, on a geophysical prospect mapped in 1926. There are 50 wells producing oil from various sands at depths between 2600 ft. and 8330 ft.

Edgerly, Calcasieu Parish, was discovered in 1912. There are 12 wells producing oil from various sands at depths between 2500 and 4200 ft.

English Bayou. See Gillis.

Eola, Avoyelles Parish, was discovered in January, 1939. It was the first field in Louisiana to produce oil

from the Wilcox formation. Three wells produce from a depth of 8450 to 8550 ft.

Fausse Pointe, Iberia Parish, was discovered in 1927, on a geophysical prospect mapped in 1926, No oil was produced between 1929 and 1936. One well is now producing at a depth of 7045 ft.

Fort Jackson. See Quarantine Bay.

Four Isle, Terrebonne Parish, was discovered in 1934, on a geophysical prospect mapped in 1927. Only two wells produced oil and the field was abandoned in 1938.

Garden Island Bay, Plaquemines Parish, was discovered in 1935, on a geophysical prospect mapped in 1928. Thirteen wells are producing oil from depths between 4000 ft. and 6800 ft.

Ged. See Vinton.

Gibson, Terrebonne Parish, was discovered in 1937, on a geophysical prospect mapped in 1934 and 1935. There are 13 wells producing oil from a depth of 9500 ft.

Gillis — English Bayou, Calcasieu Parish, was discovered in 1934, on a geophysical prospect mapped in 1928 and in 1931. The English Bayou extension was discovered in 1935. There are 77 wells producing from depths between 5200 ft. and 7500 ft.

Golden Meadows, Lafourche Parish, was discovered in December, 1938. One well is producing from a depth of 8500 ft.

Grand Bay, Plaquemines Parish, was discovered in July, 1938. Production is obtained at a depth of 6140 ft.

Grande Ecaille. See Lake Washington.

Grosse Tete. See Choctaw.

Gueydan, Vermilion Parish, was discovered in 1932, on a geophysical prospect mapped in 1929. Five wells produce oil from a depth of 4000 ft.

Hackberry. See Old Hackberry.

Hager. See Section 28 structure.

Harang, Lafourche Parish, was discovered in 1936, on a geophysical prospect mapped in 1933. There are 22 wells producing oil from five sands at depths between 5100 ft. and 6900 ft.

Henderson, St. Martin Parish, has not as yet produced any oil.

Hester. See Convent.

Horseshoe Bayou, St. Mary Parish, was discovered in 1937, on a geophysical prospect mapped in 1929. Two wells are producing oil from a depth of 10,800 ft.

Iberia. See New Iberia.

Iowa, Calcasieu and Jefferson Davis parishes, was discovered in 1931, on a geophysical prospect mapped in 1929. There are 60 wells producing oil from four sands at depths of 4350 to 4500 ft., 6600 to 6700 ft., 6870 to 6950 ft., and 6960 to 6980 ft.

Jeanerette, St. Mary Parish, was discovered in 1935, on a geophysical prospect mapped that year. There are 26 producing wells, completed at depths of 6600 to 6700 ft., 7010 to 7050 ft., 7485 to 7498 ft., and 10,274 to 10,292 ft.

Jefferson Island, Iberia Parish, although it has produced salt for many years, first produced oil in June, 1938. Two wells are producing oil from a depth of 8175 ft.

Jennings, Acadia Parish, was discovered in 1901. Flank production was discovered in 1929. Eighty-eight wells produce oil from several sands at various depths between 1650 ft. and 8600 ft.

Kelso Bayou. See East Hackberry.

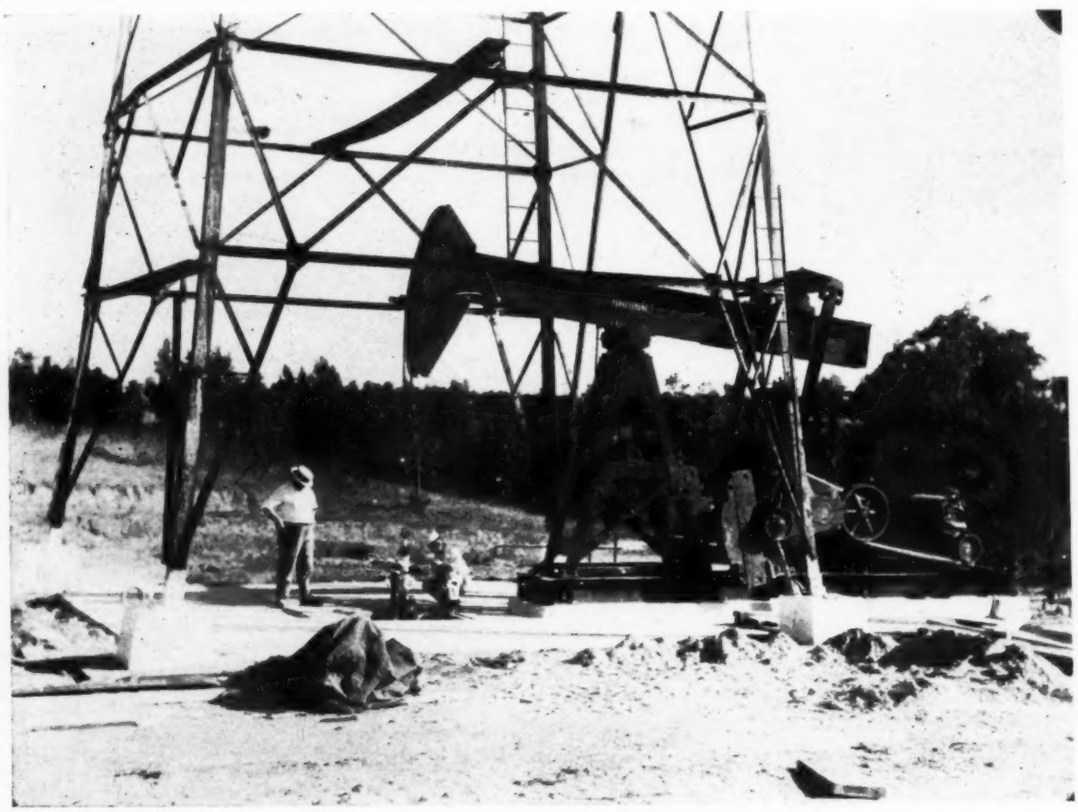
Lafitte, Jefferson Parish, was discovered in 1935, on a geophysical prospect mapped in 1933. There are 28 wells producing oil from a depth of 9600 ft.

Lake Barre, Terrebonne Parish, was discovered in 1929, on a geophysical prospect mapped that year. There are 26 wells producing oil from depths of 3490 ft. to 3800 ft.

Lake Hermitage, Plaquemines Parish, was discovered in 1934, on a geophysical prospect mapped in 1928. One well is now producing oil from a depth of 8700 ft.

Lake Long, Lafourche Parish, was

Rigging-up to pump a well in the Lisbon field



IN LOUISIANA

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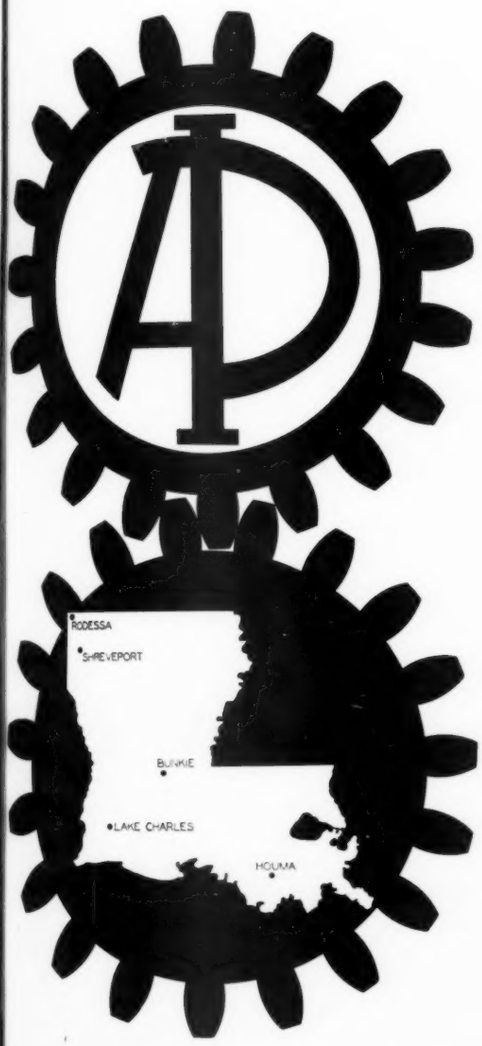

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discovered in 1937, on a geophysical prospect mapped in 1936. Six wells are producing oil from depths exceeding 9300 ft.

Lake Mongouloi structure, St. Martin Parish, has as yet produced no oil.

Lake Pelto, Terrebonne Parish, was discovered in 1929, on a geophysical prospect mapped in 1928. Seven wells are producing oil from several sands at depths between 5400 ft. and 6500 ft.

Lake Verrett, St. Martin Parish, was discovered in December, 1938. Two wells are producing at a depth of 8000 ft.

Lake Washington, Plaquemines Parish, was discovered in 1931. Seven wells are producing oil at depths of 1150 ft. and 6300 ft.

Leeville, Lafourche Parish, was discovered in 1931, on a geophysical prospect mapped in 1930. There are 104 wells producing from several sands at various depths between 3300 ft. and 5050 ft.

Lirette, Terrebonne Parish, produced gas only until 1927, and was then abandoned, but in 1937 yielded distillate. Four wells now produce at depths of 8400 ft. and 10,520 ft.

Little Bayou. See New Iberia.

Lockport, Calcasieu Parish, was discovered in 1924. There are 23 wells producing oil from several sands at depths between 2200 ft. and 6900 ft.

McElroy. See Sorrento.

New Iberia, Iberia Parish, was discovered in 1917. There are 59 wells producing from several sands at depths between 1075 ft. and 6680 ft.

North Crowley, Acadia Parish, was discovered in 1937, on a geophysical prospect mapped in 1935. There are 13 wells producing oil from depths of 7100 ft. and 8100 ft.

North Tepetate, Acadia Parish, was discovered in October, 1938. Three wells are producing from sands at depths of 7950 ft., 8400 ft., and 8980 ft.

Old Hackberry, Cameron Parish, although prospected from 1902, did not yield oil until 1928. There are now 64 wells producing oil from several sands at depths between 2950 ft. and 6800 ft.

Old Houma. See Lirette.

Port Barre, St. Landry Parish, was discovered in 1929, on a geophysical prospect mapped in 1926. There are 30 wells producing oil from sands at depths between 3120 ft. and 4860 ft.

Potash structure, Plaquemines Parish, has not as yet yielded oil.

Quarantine Bay, Plaquemines Parish, was discovered in 1937, on a geophysical prospect. Five wells produce oil from a depth of 8200 ft.

Raceland, Lafourche Parish, was discovered in January, 1938. Three wells are producing oil at depths of 7200 ft. and 10,215 ft.

Roanoke, Jefferson Davis Parish, was discovered in 1934, on a geophysical prospect mapped in 1928. There are 28 wells in the field producing oil from depths between 7780 ft. and 9800 ft.

Rose. See Venice.

St. Martinville, St. Martin Parish, was discovered in 1935, on a geophysical prospect mapped in 1934. Two wells produce oil at a depth of 5650 ft.

Section 28 structure, St. Martin Parish, has not as yet produced oil.

Sorrento, Ascension Parish, was discovered in 1928. Six wells produce oil from a sand at a depth of 4300 ft. and from other sands.

South Elton, Jefferson Davis Parish, was discovered in 1937, on a geophysical prospect mapped in 1936. One well produces from a depth of 8950 to 8996 ft.

South Houma, Terrebonne Parish, was discovered in November, 1938. One well is producing oil from a depth of 10,305 ft.

South Jennings, Jefferson Davis Parish, was discovered in 1936, on a geophysical prospect mapped in 1934 and 1935. Two wells produce distillate at a depth of 8640 ft.

South Roanoke, Jefferson Davis Parish, was discovered in 1937, on a geophysical prospect mapped in 1935. Three wells are producing from a depth of 8550 ft.

Spanish Pass. See Venice.

Starks, Calcasieu Parish, was discovered in 1927, on a geophysical prospect mapped in 1925. There are 20 wells producing from depths of 525 ft., 1500 ft., 3025 ft., 3420 ft., 3720 ft., 4100 ft., and 4800 ft.

Sulphur, Calcasieu Parish, was discovered in 1926. There are 68 wells producing from depths of 2760 to 2950 ft., 3150 to 3575 ft., 3985 to 4200 ft., 4300 to 4525 ft., 4775 to 5175 ft., and 5325 to 5700 ft.

Sweet Lake, Cameron Parish, was discovered in 1926. Seven wells produce at depths of 5910 ft., 6800 ft., and 7350 ft.

Tepetate, Acadia Parish, was discovered in 1935, on a geophysical prospect mapped in 1934. There are 56 wells producing oil and distillate from a depth of 8230 to 8450 ft.

Timbalier Bay, Lafourche Parish, was discovered in January, 1938. One well produces at a depth of 6960 ft.

University. See Baton Rouge.

Valentine. See Harang.

Venice, Plaquemines Parish, was discovered in 1937, on a geophysical prospect mapped in 1928. It lies in the salt marshes. Seven wells produce oil at a depth of 7200 ft.

Ville Platte, Evangeline Parish, was discovered in 1937, on a geophysical prospect. This field was the first to produce oil from the Sparta formation. There are 39 wells producing at a depth of 8975 to 9040 ft.

Vinton, Calcasieu Parish, was discovered in 1910. There are 73 wells producing from depths of 1870 to 2600 ft., 3450 to 3500 ft., and 3650 to 3960 ft.

Welsh, Jefferson Davis Parish, was discovered in 1903. There are 16 wells producing oil at depths of 1000 to 1300 ft. and 1780 to 3000 ft.

West Gueydan, Vermilion Parish, was discovered in July, 1938. One well is producing from a depth of 7145 ft.

West Hackberry. See old Hackberry.

West Lake Verrett. See Lake Verrett.

White Castle, Iberville Parish, was discovered in 1929. Ten wells produce from four sands at depths between 5175 ft. and 8940 ft.

Woodlawn, Jefferson Davis Parish, was discovered in February, 1938. Four wells produce from a depth of 8200 to 8900 ft.

NORTH LOUISIANA

Abington. See Bull Bayou.

Bellevue, Bossier Parish, first produced oil in 1921 and gas in 1928. The oil is obtained from the Nacatoch sand at a depth of 360 to 370 ft. The gas comes from the Tokio and Trinity formations at depths of 1010 to 1035 ft. and 1790 to 1815 ft.

Bear Creek, Bienville Parish, was discovered in 1937. Three wells produce gas from the Pine Island formation at a depth of 6670 to 6705 ft.

Bethany, Caddo Parish, first produced gas in 1928. Most of the field lies in Texas.

Bisteneau, Bossier and Bienville parishes, was discovered in 1926, produced oil for several years from a depth of 2000 to 2600 ft., and was then abandoned. In 1936 distillate was discovered in the Pine Island formation at a depth of 5150 ft., and two wells are now producing.

Blanchard. See Longwood.

Bull Bayou, De Soto and Red River parishes, include Abington, Crichton, and Naborton, as well as Bull Bayou. Gas was discovered in 1912 and oil in 1913. Oil and gas are obtained from the Nacatoch sand at a depth of 800 ft. and the Paluxy sand at 2600 ft.

Caddo-Pine Island, Caddo Parish, first produced gas commercially in 1905 and oil in 1906. There are several separate fields, and the productive area

extends into Texas. The Nacatoch sand at a depth of 800 ft. yields gas and some oil; the Annona chalk at a depth of 1400 to 1700 ft. yields oil, and the Paluxy sand, at a depth of 2200 ft., yields oil and gas. In 1925 oil and gas were discovered in the Pine Island formation at a depth of 3600 to 3900 ft.

Carterville, Bossier Parish, was discovered in 1927. The Buckrange sand at a depth of 3050 ft. produced gas and a small quantity of oil. In 1929, oil was found in the Brownstown-Tokio sand at a depth of 3140 ft.

Converse, Sabine Parish, was discovered in 1932. Oil is produced from the Nacatoch sandy limestone at a depth of 1525 ft., the Saratoga chalk at 1600 to 1650 ft., the Annona chalk at 1850 to 1950 ft., and a Lower Cretaceous zone at 3280 to 3300 ft. Gas is produced from a depth of 3380 to 3400 ft. Acid-treatment has been necessary to stimulate production from the lime zones.

Cotton Valley, Webster Parish, first produced gas in 1922 and oil soon thereafter from the Buckrange sand. In 1926 gas found in the Glen Rose Anhydrite at a depth of 4380 ft. In 1936 oil was found in the Travis Peak formation at a depth of 5550 ft. The Cotton Valley formation, including the Bodcaw and at least seven other sands, first produced oil in January, 1937, from a depth of 8100 ft., but the gas/oil ratio is very large. In July, 1938, oil was discovered in another sand at a depth of 8600 ft.

Crichton. See Bull Bayou.

Cross Lake. See Shreveport.

De Soto. See Bull Bayou.

Driscoll, Bienville Parish, first produced gas from the Lower Glen Rose formation at a depth of 6140 ft. in 1936. In 1937 gas and condensate were found in the Travis Peak formation at a depth of 7150 to 7220 ft.

Dubberly. See Sibley.

Elm Grove, Bossier and Caddo parishes, first produced oil and gas in 1916, at a depth of 800 to 840 ft. In 1918 deeper gas-producing strata were discovered.

Epps, East Carroll and West Carroll parishes, was discovered in 1928. Gas is produced from a depth of 2340 ft.

Georgetown. See Urania.

Gleason. See Shongaloo.

Greenwood. See Longwood.

Haynesville, Claiborne and Webster parishes, was discovered in 1921. Oil was obtained from the Buckrange sand at a depth of 2850 ft. In 1926 the Glen Rose formation yielded gas at a depth of 4330 ft. and a lower sand produced oil from a depth of 4530 ft.

Holly, De Soto Parish, was discovered in 1930. A few wells produce oil from a channel sand, probably equivalent to the Woodbine sand.

Homer, Claiborne Parish, was discovered in 1919. Oil is obtained from the Nacatoch sand at a depth of 2040 to 2065 ft. and the Buckrange sand at 2790 to 2805 ft.

Lisbon, Claiborne and Lincoln parishes, was discovered in 1936. Oil is produced from the Pine Island formation at a depth of 5370 ft. Acid-treatment greatly increases the productivity of the wells.

Longwood, Caddo Parish, was discovered in 1927. Gas was first obtained from the Travis Peak formation at a depth of 5900 ft. and later from several shallower sands.

Monroe, in Union, Ouachita, and Morehouse parishes, underlies an area of 390 square miles. Gas was first produced in 1916 from the Navarro formation at a depth of 2300 ft. Natural gasoline and carbon black are important products.

Montcalm. See Simsboro.

Naborton. See Bull Bayou.

Panola. See Bethany.

Pine Island. See Caddo.

Pleasant Hill, Sabine Parish, first produced oil from the Paluxy formation at a depth of 3180 to 3250 ft. in 1927, but a single well produced from 1914 to 1936 from a sand at a depth of 1540 ft.

Ramsey, De Soto Parish, first produced some oil in 1937 from a depth of 3000 ft. The natural gasoline is much more important than the oil.

Red River. See Bull Bayou.

Richland, Richland Parish, was discovered in 1926. Gas is obtained from a depth of 2320 to 2500 ft.

Rochelle. See Urania.

Rodessa, Caddo Parish, and extending into Arkansas and Texas, produced gas from the Rodessa member of the Lower Glen Rose as early as 1930, at a depth of 5500 ft., but oil was not discovered until 1935. The Rodessa member is more than 400 ft. thick and includes the Hill gas sand, found throughout the field, the Neugent sand, a lens in the eastern end of the field, the Glovd sand, or Caddo Levee Board, including the Upper Levee Board, Mitchell, and Lower Levee Board, and finally the Dees Young, which has produced approximately 70 percent of the oil.

Ruston, Lincoln Parish, first produced gas in 1937, the single well being shut-in because of lack of pipe line.

Sarepta. See Spring Hill.

Shongaloo, Webster Parish, was discovered in 1922. Oil and gas are obtained from the Buckrange sand at a depth of 2665 ft. In May, 1938, a new sand was discovered at a depth of 8990 ft., which produced oil and gas.

Shreveport, Caddo Parish, was discovered in July, 1938. Oil is produced from a limestone at a depth of 5540 ft.

Sibley, Webster Parish, was discovered in 1936. Gas and condensate are produced from the Pine Island formation at a depth of 5590 ft.

Simsboro, Lincoln Parish, was discovered in 1935. Gas is obtained from the basal Glen Rose formation at a depth of 5300 ft. and from the Travis Peak at a depth of 6575 ft. Some oil and condensate are produced.

Sligo, Bossier Parish, was discovered in 1922, gas being obtained from Nacatoch sand at a depth of 870 ft. In 1923 gas was found at depths of 2450 and 2590 ft. In 1927 gas was found in the Rodessa member (Jeter) at a depth of 4275 ft. In 1936 the Pettet Zone of the Pine Island formation produced gas at a depth of 5200 ft., and later wells found oil in this zone. In 1937 oil was found in a porous limestone at a depth of 3120 ft.

Spring Hill, Bossier and Webster parishes, first produced gas in 1923 and oil in 1929 from the Buckrange and Tokio formations at depths of 2690 ft., 3060 ft., and 3150 ft.

Sugar Creek, Claiborne Parish, was discovered in 1930. Gas was obtained from the Rodessa member at a depth of 4310 to 4590 ft. Oil was found in the Travis Peak formation in May, 1936, and in another zone at a depth of 5700 ft. in November, 1936.

Tullos. See Urania.

Union Church. See Driscoll.

Urania, in La Salle, Grant, and Winn parishes, includes Tullos, Georgetown, and Rochelle areas. Oil and gas were first produced in 1925. The Cane River formation produces from a depth of 1500 to 1550 ft.

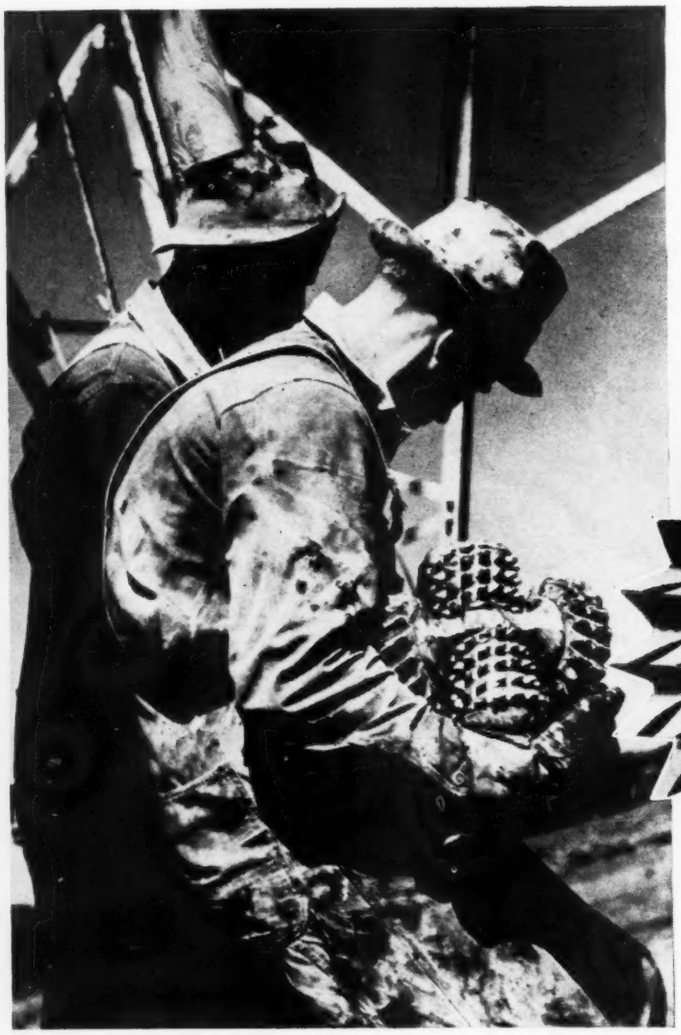
White Sulphur Springs, La Salle Parish, was discovered in 1927, produced a small quantity of oil from the Jackson formation at a depth of 780 to 805 ft., and was abandoned in 1932.

Zwolle, Sabine Parish, was discovered in 1928. Oil is produced from a detrital zone on the southeast flank of the Sabine Uplift. Depth of the producing zone is 2280 to 2440 ft.

Already ranking high as an oil-producing state, Louisiana has a promising future. Improvement in deep-drilling practice and in scientific methods of uncovering deeply-buried structures augurs well for the development in the future of prolific fields equaling or surpassing any developed in the state to date.

REED ROCK BITS an

Are leaders in oil fields throughout the worl be



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Geophysics Has Played Important Role in Oil Discoveries

PETROLEUM ENGINEER EXCLUSIVE FEATURE

Applied successfully to locate and delimit structures likely to produce oil or gas or both

By RALPH H. KING

FOR several years geophysical equipment and methods have been used successfully to locate and delimit structures likely to produce oil or gas or both. The effective application of geophysics to the search for oil in Louisiana is indicated by the discovery of productive salt domes along the Gulf Coast by means of reflection and refraction seismograph and torsion balance. Other methods have been used and new methods are being introduced, but the greater part of the work has been done by these better-known methods.

In 1938 there were 49 to 75 geophysical crews working in southern Louisiana. The number of seismograph crews varied from 38 to 51, and the number of torsion-balance crews from 5 to 14. The other crews used miscellaneous methods, some of which are being tested experimentally.

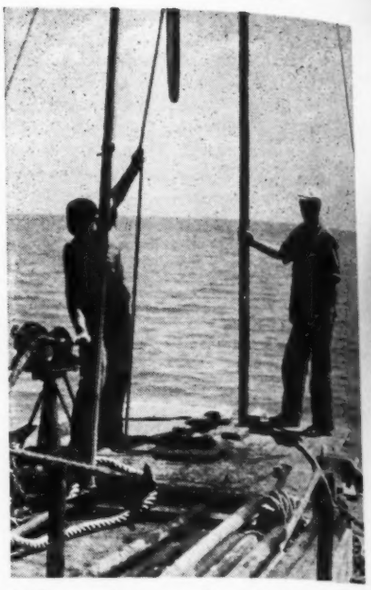
The torsion balance is not so extensively used for finding salt domes along the Gulf Coast as it was in earlier years, but more of these instruments are being used in the "Conroe trend" in southwestern and central Louisiana than any other type.

For seismographic prospecting in areas where reflection study is impracticable, the older refraction method was recently revived, and in the open waters along the coast it has virtually supplanted the younger method.

The gravity meter was used very successfully in 1938. Grand Bay and Quarantine Bay fields in Plaquemines Parish and Timbalier Bay field in Lafourche Parish were discovered by this instrument and verified by reflection seismograph.

It is difficult to evaluate the importance of any particular geophysical survey. Much ground may be covered before any evidence is found of structure favorable for the accumulation of oil. Even after the structure has been found and outlined, several test wells are required to develop or condemn it, and the drilling of the wells takes time.

Much of the prospective oil-producing area of Louisiana lies under shallow to relatively deep water in the bayous and the Gulf of Mexico itself. For use in seimographic prospecting, barges have been equipped with light drilling rigs for drilling shot holes 15 to 20 ft. deep at sites covered by water. Thus far only those areas covered by shallow water have been examined, but it is reasonable to expect that as equipment is devised for drilling wells in deeper, more open water, geophysical prospecting will extend to such areas.



Drilling seismographic shot holes from a barge

More difficult to traverse than the open water is the swampy terrain of the coastal marshes. The ground is too soft and spongy to support any ordinary vehicle, but there is not enough open water to permit the use of boats. For use in such country various types of "marsh buggies" have been developed. These vehicles consist of a tractor- or truck-type chassis and body supported by wheels equipped with large balloon tires. These extra large tires are made of rubber or metal and are of sufficient size to float the entire vehicle in water if necessary. Deep lugs, belts, or paddles are affixed to the tires to propel the "buggy" across water, but these appliances are sufficiently rugged to support the weight of the buggy on highways or hard ground. The marsh buggy therefore is able to transport crews and equipment over any kind of terrain.

The "marsh buggy" is an indispensable piece of equipment in the swampy areas of South Louisiana

IN LOUISIANA TOO—

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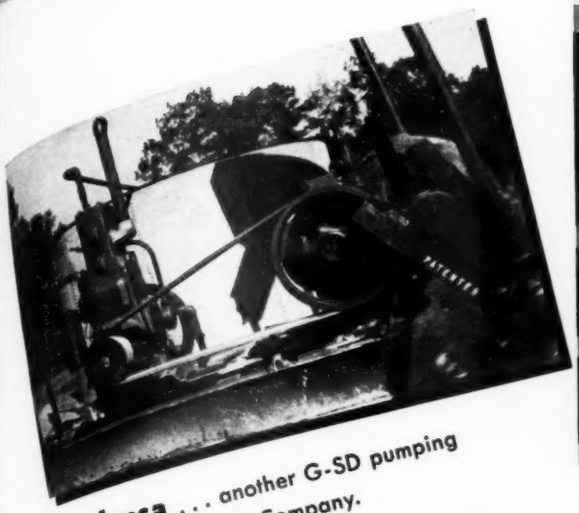
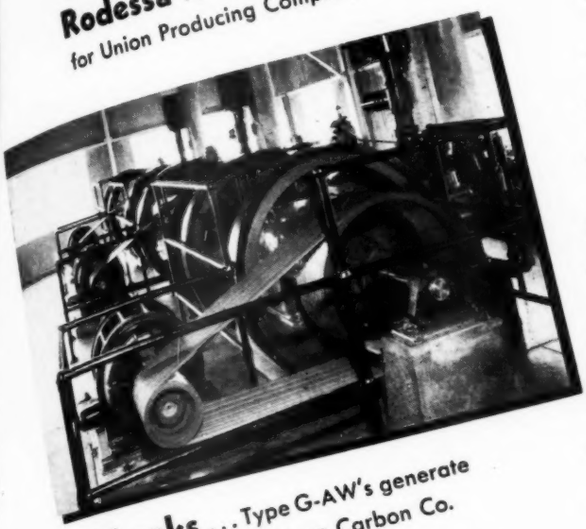
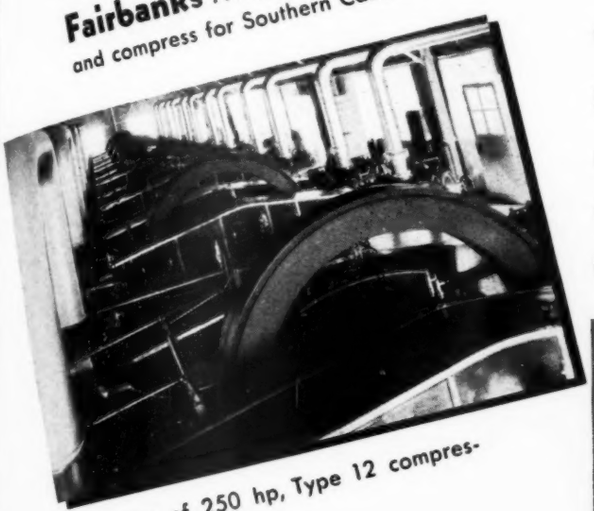


Rodessa . . . another G-SD pumping for Union Producing Company.



Fairbanks . . . Type G-AW's generate and compress for Southern Carbon Co.



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Louisiana Leads in Number of Deep Wells Drilled

To date 82 tests have been drilled in the state to a depth of 10,000 ft. or greater—Terrebonne leads all other parishes with 16 tests, having total footage of 183,916 ft.

By H. LEE FLOOD
Associate Editor

As a prelude to discussing Louisiana's important contribution to the drilling of 10,000-ft. wells, a review of deep drilling in general is perhaps advisable.

World Events in Deep Drilling

Since 1931 so many records for "greatest depth ever attained" have been established and broken that it has been difficult for anyone not directly interested in deep drilling to follow the progress of events closely. The year 1931 is important. It was in May of that year the first 10,000-ft. hole in the world was drilled in Ventura County, California. Drilled to a depth of 10,030 ft., the well was plugged-back to obtain production at a shallower depth. In August of the same year, the world's record for depth was established when a well was drilled to a depth of 10,585 ft. in Mexico. Not for two years was this record broken even though a 10,079-ft. test well had been drilled in Oklahoma in October, 1931, and a 10,296-ft. test well in California in July, 1932. The Mexican record was broken in June, 1934, when a well in Kern County, California, reached a depth of 11,000 ft. for the first time—the total depth of this well was 11,377 ft. A month later (July, 1934) Roumania made its bid for world honors by having a well drilled to 11,092 ft. Not quite breaking the depth record, this well does have the honor of being the first perforating job below 11,000 ft. Texas entered the 10,000-ft. class for the first time in November, 1934, with a 10,050-ft. hole in Frio County.

Louisiana's Deep-Well History

Louisiana, perhaps slow in entering the 10,000-ft. rank of deep drilling, has made up for lost time by piling up more 10,000-ft. tests than any other state or country. The first 10,000-ft. test in Louisiana was in St. Landry Parish. A total depth of 10,002 ft. was reached in this test during January, 1935.

It should be noted that all the pioneer 10,000-ft. or deeper tests thus far mentioned failed to find commercial production below 10,000 ft. and were either plugged-back or abandoned. To Louisiana goes probably the most important record—that of being the first in the world to establish commercial production below 10,000 ft.

First production below 10,000 ft. was obtained almost simultaneously in two wells only a week apart by the same company in the same field. The field was LaFitte in Jefferson Parish and the company was The Texas Company. This company's No. 5 Rigoletts, drilled to a total depth of 10,942 ft., was plugged-back to 10,244 ft. and perforated from 10,030-10,110 ft. Completed January 7, 1937, for an initial flow of 1636 bbl. per day, this well is the first in which commercial production was obtained below 10,000 ft. On January 13, 1937, the same company's No. 1 R. C. Milling was completed at a total depth of 10,040 ft. to take its place as the second 10,000-ft. commercial producer in the world.

Thus, although it has been exactly eight years ago this month since the world's first 10,000-ft. test was drilled in California, it has been less than 2½ years since 10,000-ft. drilling efforts were first rewarded with commercial production in Louisiana.

To date, 82 tests have been drilled in Louisiana to 10,000 ft. or deeper. The combined footage in these wells is 899,007 ft., an average of 10,964 ft. per well. The shallowest of these tests was 10,002 ft.; the deepest was 13,410 ft. The latter record for depth (in Louisiana) was attained by the Fohs Oil Company in its No. 1 Bay Baptiste in the Bay Baptiste field, Terrebonne Parish, during August, 1938.

It is interesting to note that 25 of the 82 deep tests in Louisiana have been drilled by The Texas Company. The total footage in the 25 Texas Company wells is 268,942 ft., an average of 10,758 ft. per well.

Because of the great number of deep tests drilled within its borders in the last four years, Louisiana can be credited with fostering and creating more interest in deep drilling than any other area in the world.

SUMMARY OF FOOTAGE IN WELLS DRILLED IN LOUISIANA TO 10,000 FT. OR MORE

Parish	1935			1936			1937			1938			1939 (first 4 months)		
	No. wells	Total footage	Avg. depth	No. wells	Total footage	Avg. depth	No. wells	Total footage	Avg. depth	No. wells	Total footage	Avg. depth	No. wells	Total footage	Avg. depth
Acadia							2	20,328	10,164	4	41,326	10,332			
Assumption													1	11,960	.....
Baton Rouge	1	10,360	.....				1	10,146	.....	4	44,458	11,115			
Cameron										1	10,506	.....			
Evangeline							1	10,622	.....						
Iberia							8	84,358	10,545	3	30,671	10,224	1	11,961	.....
Jefferson	2	21,333	10,667							7	77,045	11,000			
Jefferson Davis										1	10,973	.....			
LaFayette										7	77,761	11,109	1	11,114	.....
LaFourche										2	21,974	10,987			
Plaquemines										1	10,270	.....			
St. Bernard										1	11,220	.....			
St. Landry	1	10,002	.....							1	10,000	.....			
St. Martin										7	75,707	10,815			
St. Mary							5	54,743	10,949	7	83,713	11,959	3	35,164	11,721
Terrebone				2	20,411	10,206	4	44,628	11,157						
Vermilion				1	12,216	.....	2	24,037	12,019						
Totals	4	41,695	10,424	3	32,627	10,876	23	248,862	10,820	46	505,624	10,992	6	70,199	11,700

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Marine Drilling Forms Large Part of Louisiana's Gulf Coast Drilling Activity

Seven hundred of 3300 wells drilled in Gulf Coast area have been in locations surrounded by water

By H. LEE FLOOD
Associate Editor

MARINE drilling in Louisiana is assuming an increasing importance in oil operations of the state as more test wells are drilled offshore in the Gulf of Mexico and additional pools are discovered thereby. The best records available indicate that approximately 700 of the 3300 wells drilled in the costal parishes of Louisiana have been in locations surrounded by water. This includes, of course, wells that have been drilled in dredged waterways.

It is not strange that so many wells and fields in Louisiana have been located in water or marshes. Water has played an important part in the history and development of the entire state. Louisiana is not only bordered by the waters of the Gulf of Mexico on the south, but the state is almost entirely surrounded by water. Of more than 3000 miles of boundary only approximately 600 miles is traversed on land. The rest of Louisiana's borders is either on the Gulf or in the Sabine, Mississippi, or Pearl Rivers. In addition to the lakes and marshes of the delta lands of the Mississippi River, the course of the Red River through Louisiana is marked by many ox-bow lakes and other characteristics of meandering, sluggish streams. All these features contribute to the general picture in Louisiana that has resulted in so many aquatic oil fields within the state.

Every one of the nine coastal parishes—Cameron, Vermilion, Iberia, St. Mary, Terrebonne, Lafourche, Jefferson, Plaquemines, and St. Bernard—contains important oil fields. It is in these parishes, particularly in Cameron and Terrebonne, that marine drilling has been required.

The most important concentration of marine activity has been in the fields of Terrebonne Parish bordering on the large embayment of the Gulf of Mexico, portions of which are called Lake Barre, Terrebonne Bay, Pelta Bay, and Timbalier Bay. In Terrebonne Bay is situated the now-famed "Port Texaco." Owned by The Texas Company, "Port Texaco" consists of three obsolete oil tankers that have been grounded in Cat Island Pass to serve as a storage and transfer point for crude oil produced in the surrounding fields. The oil may be transferred by barge to ocean-going tankers anchored in the deeper waters of the Gulf.

In many marshy areas where neither firm footing nor navigable waters prevailed, oil operators have dredged channels and deliberately prepared for marine drilling and operation as the most economical means of gaining access to the area for development. The vast system of canals and channels created in this manner has served as a network of "highways" for inter-field traffic. These water "roads" have also helped solve the problem of transporting production to market in areas where pipeline operation and maintenance, to say nothing of construction, would be out of the question.

The first wells in water were drilled from piling substructures and this practice is still followed by some companies. Drilling barges have come into more general use, however, by the larger companies able to foresee enough drilling of this type to justify the purchase of a barge and its accessory equipment.

Marine drilling has been confined almost entirely to the coastal fields of Louisiana, as might be expected. If activity continues to be centered in the coastal area as it is at the present time, marine drilling operations may be expected to be even more prevalent than they are now.

Discovery well in Raceland field, one of areas in which marine drilling is employed

By
H. LEE FLOOD
Associate Editor

Oil operators cooperate fully with state in preventing pollution—welfare of trapping and fishing industries of Louisiana depends upon uncontaminated water

To prevent pollution when pulling rods or tubing in Lake Barre field derrick floors are of concrete and so constructed that oil drains to the center

Prevention of Pollution Is Important to Louisiana

NO single phase of oil operations in Louisiana has received more attention than the prevention of pollution. Most oil operators have coöperated fully with the State Department of Conservation in adopting every safeguard necessary to avoid contamination of the waters of Louisiana with the products or wastes of oil-field operations. In many instances the companies have adopted, voluntarily, measures that would further assure the absence of contamination. Consequently, a very friendly relation exists between the state and the oil industry because of the results that have been accomplished.

The more common sources of pollution in oil-field work may be quickly listed:

1. Oils, greases, and other "foreign" materials employed in drilling operations.
2. Oil lost in a blowout of a "wild" well or in the careless completion of a well.
3. Oil leaks in the surface equipment of a producing well or of storage facilities.
4. Salt water produced with the oil.

It is gratifying to observe the almost complete absence of pollution from any of these sources in the fields of Louisiana. Spills of oils, greases, and other fluids necessary in drilling operations have been eliminated by the use of proper containers and traps, but more through proper instructions to the drilling crews and rigid enforcement of rules concerning procedure and practice. Blowouts and wells out of control are sometimes unavoidable but operators in Louisiana have reduced the number of these accidents to a remarkable degree. No expense is spared to safeguard against trouble.

Oil leaks at well-heads, in lead-lines, in lease tanks, in barge-loading facilities—all have caused a certain amount of pollution in Louisiana at one time or another. Many devices have been designed and are used to prevent trouble from these sources. It is customary practice to construct a pan or trough under the well-head connections of a producing well situated over water to trap any oil that might leak from the fittings. Similar safeguards, some of them quite elaborate and costly, are used at all points where a spill might occur.

Disposal of salt water production is a problem that has been met squarely by the majority of oil producers in Louisiana. Although it may involve a greater investment, the simplest means of disposing of salt water is to pump it underground into some shallow formation carrying brackish or salt water. This method disposes of the brine quickly and cleanly. Subsurface disposal has been adopted quite widely in Louisiana by most of the major operating companies. Older methods still in use involve the evaporation of the brine in open pits.

Some of the fields in which subsurface brine disposal has been adopted include: Bosco, Big Lake, Gillis and English Bayou, Iowa, Jeanerette, Lake Barre, Lockport, New Iberia, and Port Barre.

In the Cheneyville field, natural gas is used as fuel to heat the brine and hasten evaporation. Among the fields in which salt water is evaporated in open pits are included Edgerly, Harang, and Welch.

Water pollution in Louisiana is more serious possibly than in most states for three major reasons. First, there is such a tremendous amount of water in the rivers, lakes, bayous, and marshes of the state. Second, these waters teem with fish and are depended upon by wild fur-bearing animals for drinking water. Third, a large number of Louisiana residents depend for their livelihood upon the revenue derived from the sale of furs and fish.

It may be of passing interest to the reader to gauge the importance of pollution prevention to the state of Louisiana in terms of dollars and cents. For example, in 1937 the values of the natural resources that would suffer most from pollution were as follows:

Fur take	$ 3,325,018
Fresh water fish	1,739,368
Salt water fish	2,088,112
Salt water shrimp	2,667,623
Oysters	3,261,528
Total	$13,081,649

In the same year, 1937, the values of the various classes of oil and gas products were as follows:

Oil	$114,702,187
Natural gas	10,540,170
Natural gasoline	4,338,993
Carbon black	2,917,953
Total	$132,499,303

Thus, though the value of fur and fish is only about ten percent of the total value of oil and gas in Louisiana, the money involved makes it imperative that these important sources of livelihood for a substantial number of the people of Louisiana not be endangered needlessly.

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For gas recycling and repressur service in the Midcontinent and G Coast distillate fields, CLARK "Angl Compressors have been almost t universal choice of operators, to d Note the "Angle" installations for cycling service shown on these pa which are a few of the CLARK "Angl installations that have been made f this purpose.

There must be reasons for this lea ership. We believe the basic explan tion to be the savings which CLA "Angles" have introduced. These s ings are: (1) Shipment assembled:

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Manufacture of Natural Gasoline in Louisiana

Twenty-four plants produced 2,319,048 gal. of gasoline in 1938—Problems in Gulf Coast area have necessitated certain departures from conventional methods of design and operation

By FRANK H. LOVE
Managing Editor

IN 1938 Louisiana's production of natural gasoline was 2,319,048 gal., extracted by 24 plants. The volume of gas used for this purpose was 128,950,671,000 cu. ft. A considerable part was from natural gas wells, some, however, being casinghead gas. No figures are available on the exact apportionment.

By far the greater part of the state's gasoline plants are of the absorption type, 20 plants coming under this classification, three being of the compression type, and one is a combination absorption-compression plant. Details of the various plants, their location, capacity, and type are given in an accompanying table.

In North Louisiana construction and operation follow a rather standard pattern. In the Gulf Coast area, however, topographical conditions and problems associated with the production of deep oil wells having high pressures have necessitated certain departures from conventional methods. An interesting example of the former is The Texas Company's plant in the Lafitte field, and of the latter the Continental Oil Company's plant at Basile in the Tepetate field.

The Texas Company's Lafitte plant is situated in the marshland area of South Louisiana. The field is 30 miles south of New Orleans and can be reached only by boat or air. This plant

Tepetate Plant of Continental Oil Company

Company	Location	Daily capacity, gal.	Type
Arkansas Natural Gas Company	Homer	5,000	Compression
Arkansas Natural Gas Company	Rodessa	40,000	Absorption
Arkansas Natural Gas Company	Simsboro	10,000	Absorption
Arkansas Natural Gas Company	Sligo	12,000	Absorption
Coltexo Corporation	Rodessa	40,000	Absorption
Continental Oil Company	Basile	20,000	Absorption
Continental Oil Company	Lake Charles	7,000	Absorption
Continental Oil Company	*Ville Platte		
East Texas Refining Company	Rodessa	8,000	Absorption
Glen Rose Gasoline Company	Rodessa	30,000	Absorption
Great National Oil Corporation	Rodessa	15,000	Absorption
Gulf Refining Company	Homer	12,000	Absorption
Gulf Refining Company	Mooringsport	5,000	Absorption
Ohio Oil Company	Haynesville	2,000	Absorption
Ohio Oil Company	Haynesville	2,000	Absorption
Ohio Oil Company	Treat	2,000	Absorption
Shell Petroleum Corporation	Iowa	15,000	Absorption
Standard Oil Company of Louisiana	Homer	5,000	Compression
Standard Oil Company of Louisiana	Trees	4,000	Comp.-Abs.
Stanolind Oil and Gas Company	Gilliam	3,000	Compression
The Texas Company	Lafitte	3,740	Absorption
Tide Water-Associated Oil Company	Rodessa	5,000	Absorption
United Gas Pipe Line Company	Sugar Creek	30,000	Absorption
United Gas Pipe Line Company	Cotton Valley	20,000	Absorption
United Gas Pipe Line Company	Myrtis	140,000	Absorption

*Under construction.

was constructed in 1937 and piling varying in length from 45 to 75 ft. had to be driven to provide a foundation solid enough to support the various units. The piling was capped and floored with 3-in. planking and a 6-in. thickness of reinforced-concrete. In addition to the problem of providing a suitable foundation other unusual factors involved are the supplying of pure water for processing, and transportation of the finished product.

Process water is brought to the plant on barges from a distance of 40 miles and every effort is made to conserve it. This is accomplished by the method of handling steam. All exhaust steam is condensed and returned to the steam plant. Process steam, which is generated at a pressure of 180 lb., is trapped from the heating coils and returned to an accumulator tank, upon which a pressure of 150 lb. is maintained, and the condensate is pumped continuously to the boilers. Exhaust steam from pumps is discharged to condensers mounted above a low-pressure condensate tank.

Finished gasoline is transported to a blending terminal at Avondale in a specially constructed all-steel barge designed for the purpose.

The Lafitte plant is a two-pressure unit. Capacity of the high-pressure side is 15,000,000 cu. ft. of gas per day and the low-pressure side has a capacity of 3,000,000 cu. ft. per day. The former operates at a pressure of 500 lb. and the latter at 25 lb.

At Basile, Louisiana, in the Tepetate field, the Continental Oil Company constructed in 1936 a crude-oil-stabilization and gasoline-recovery plant. The wells in the field are deep and the pressures high. Large volumes of gases are dissolved in the crude oil and if the wells were to be produced in the usual manner a large loss by evaporation would result, caused by the sharp reduction in pressure.

Although the crude-oil-stabilization portion of the project is interesting, the present discussion will be limited to a consideration of the facilities for and methods of recovering the natural gasoline.

The plant has a capacity of 50,000,000 cu. ft. of gas per day and manufactures about 20,000 gal. of gasoline per day.

Removal of gasoline is by the absorption method, conventional in all but two respects. Lean absorption oil is cooled by heat exchange with the cool crude oil from the plant separators to a temperature below that which would be possible by water-cooling. The second departure from usual operating methods is the procedure for handling plant vapors. Vapors flashed from the crude in the first stage of pressure reduction and vapors flashed from the rich oil in the first and second stages are treated for gasoline recovery by the reabsorber. Vapors flashed from the crude oil in the second stage, those removed from the crude oil by the stabilizer from the reflux separator, and those from the surge tank of the distillation unit are taken by the recompressor and delivered directly to the gasoline stabilizer for gasoline recovery.

In the Ville Platte field a plant similar to the one at Basile is under construction by the Continental Oil Company. The plant for gasoline extraction is designed for a throughput of 25,000,000 cu. ft. of gas per day.

United Gas Pipe Line Company's gasoline plant in Cotton Valley field

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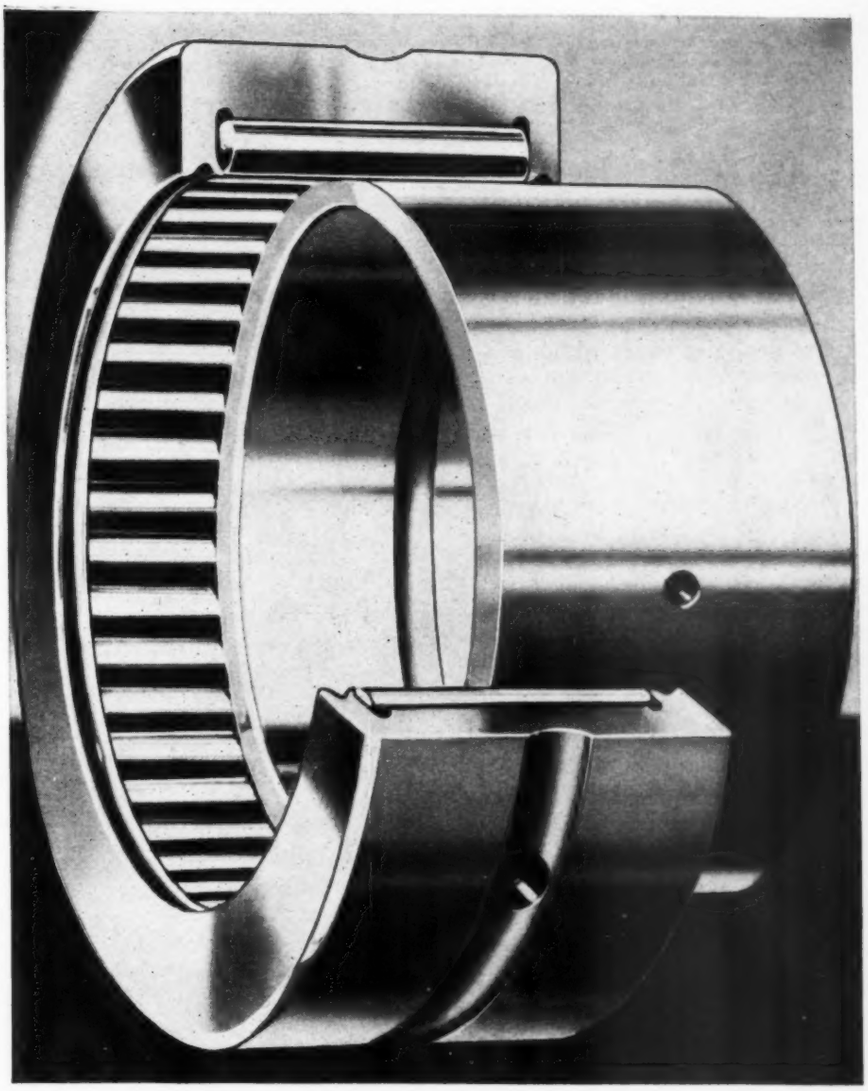

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Pressure Maintenance In Lousiana Is Demonstrating Real Value

This logical method of preventing premature abandonment of wells is meeting with increased acceptance

By H. LEE FLOOD
Associate Editor

IT is gratifying to the advocates of pressure maintenance to witness the increasing acceptance of this important aid to oil recovery in the fields of Louisiana. Efficient extraction of distillate reserves dictates an almost mandatory use of pressure maintenance to avoid loss of the heavier fractions underground. Other high-pressure reserves in Louisiana where high gas-oil ratios are unavoidable because of the large amount of gas in solution have more or less forced the acceptance of pressure maintenance as the only sane method of preventing premature abandonment.

Until recently, the general status of pressure maintenance could best be summarized as in the following statement:

"Pressure maintenance is one of the most discussed but least practiced of any type of operation in the oil industry. Its economic worth, although proven, is admitted by only a small percentage of operators. The reluctance of many oil producers, with competent engineering staffs, to take advantage of proven recovery methods involving pressure maintenance is not easily understood."[1]

It is fortunate for the industry that the aggressive deep-drilling program in Louisiana during the last four or five years has uncovered so many high-pressure reserves. In nearly every instance, tremendous volumes of gas both free and dissolved have been found. In the distillate fields, of course, the hydrocarbons are in the gaseous phase. The effect of this has been to bring out in the most effective way the need for conservation of the gas—more important, conservation, at least restoration of the gas energy.

In past instances when the ratio of gas to oil in the reservoir was normal, operators have too often been satisfied with a moderate effort to control the gas-oil ratio of natural production. In wells such as those in Louisiana where it is next to impossible to maintain a low gas volume per bbl. of oil by conventional means of control, a different production procedure has been adopted in which pressure maintenance plays an indispensable part. The satisfactory results in high-pressure operation have even pointed the way more clearly to the general value of pressure maintenance in low-pressure production.

One advantage has resulted from pressure maintenance that is not generally recognized. The conventional method of choking a well in the bore or at the well-head usually results in a multitude of vexing problems such as paraffin, hydrates, and other freezing troubles that often accompany the pressure drop in flow-beans or choke-nipples. In the modern method of returning gas to the formation, pressure control of production can be brought "upstairs" to be governed in one or a series of separators. The knowledge that the gas is to be saved and returned underground permits the production engineer to experiment over a wider range to obtain the most satisfactory combination of oil and gas production. In this way a closer approach may be made, when desired, to the conditions of natural flow. The production engineer may increase the gas-oil ratio appreciably so long as the "net" gas produced per bbl. of oil remains satisfactorily low.

One of the better-known pressure-maintenance projects in Louisiana is that of the Continental Oil Company's Tepetate plant at Basile. A complete description of this interesting installation appeared in the September, 1936, issue of *The Petroleum Engineer*.[2] Placed in operation in 1936 this project continues to be one of the outstanding examples of sound pressure-maintenance practice. The plant was designed originally to avoid the severe losses in conventional production methods by evaporation of the lighter fractions dissolved in the crude oil. In other words, stabilization of the crude oil production was the primary purpose of the plant. The return of gas underground was perhaps a secondary function at the outset although its value was fully recognized. Certainly the performance since 1936 has shown clearly the value of the pressure-maintenance part of the work.

The initial bottom-hole pressure in the 8313-ft. zone in the Tepetate field was 3640 lb. per sq. in. At the time gas was first returned to the formation slightly more than 2,000,000 bbl. of oil had been produced and the formation pressure had dropped to 3040 lb. per sq. in. Since gas has been returned to the sand the decline in pressure has been greatly retarded; the pressure has dropped to only slightly less than 3000 lb. per sq. in. Production of oil per lb. of pressure drop was 3650 bbl. before the pressure-maintenance program was begun. Since then the production of oil per lb. drop in formation pressure has increased to nearly 50,000 bbl. That the Continental Oil Company has found pressure maintenance profitable is indicated by the number of projects it has initiated in other fields in Wyoming and Texas as well as in Louisiana.

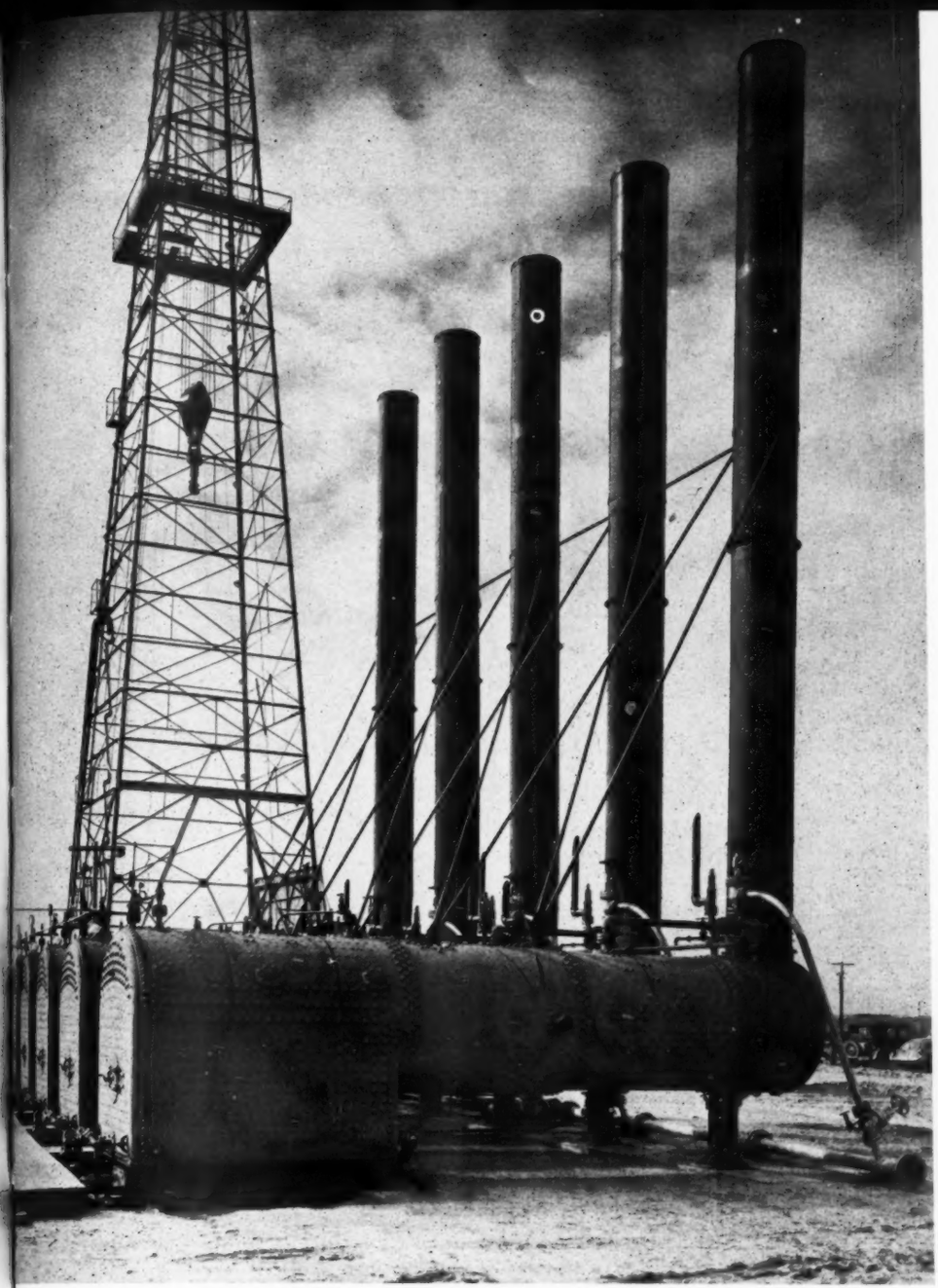
Pressure maintenance is not by any means new to Louisiana in the Tepetate project. As early as 1929, repressuring as an initial step to pressure maintenance was begun in the Haynesville pool, Claiborne Parish. An early account of this project appeared in the October, 1930, issue of *The Petroleum Engineer*.[3] Pressure maintenance has been continued in this field extending the life of the pool beyond its normal expectancy and promising much in the years to come.

One of the most recent plans for pressure maintenance is that of the Ohio Oil Company in the Cotton Valley field, Webster Parish, Louisiana. The discovery of gas in 1922 marked the first activity in this field. The really important oil production was not revealed until 1936. Gas will be returned to the Bodcaw sand. At present, the project is in the experimental stage. As soon as the desired data have been determined on which to base the field-wide operation, pressure maintenance will become a standard part of operations in the Cotton Valley field.

[1] "Pressure Maintenance." by E. O. Bennett, a paper delivered at the Eighth Mid-Year Meeting, A.P.I., Wichita, Kansas, May 24, 1938.

[2] "Crude Oil Stabilization and Gasoline Recovery Plant of Continental Oil Company at Basile, Louisiana," by E. O. Bennett, *The Petroleum Engineer*, September, 1936.

[3] "Development and Progress of the Haynesville Pool Repressuring Project," by Millard H. Flood, *The Petroleum Engineer*, October, 1930.



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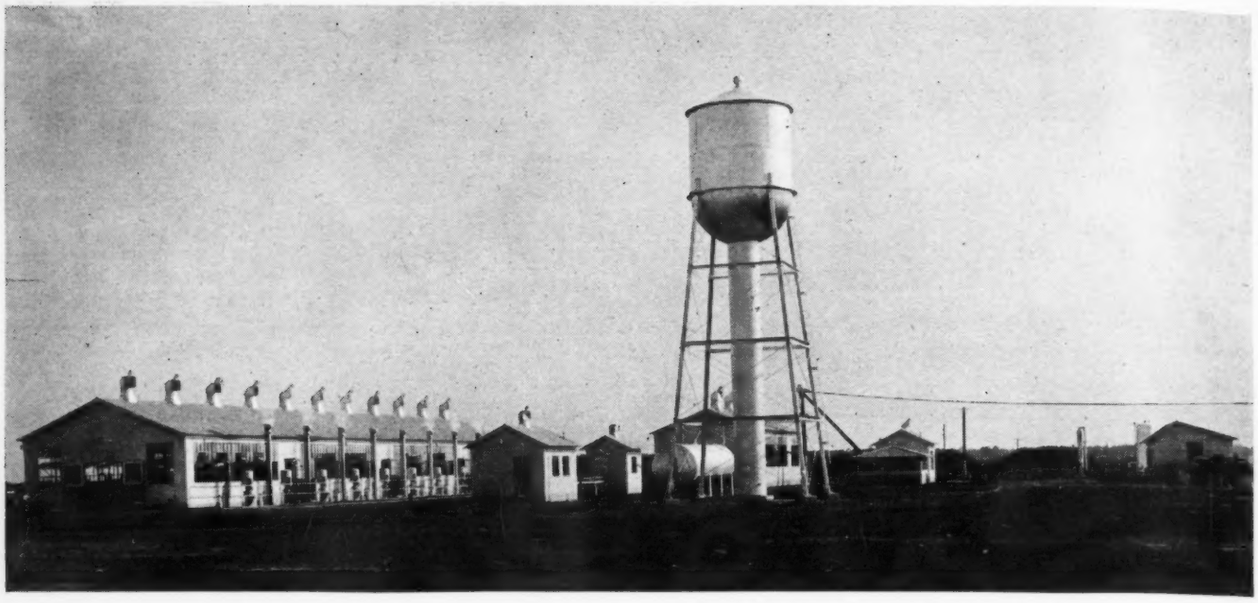

General view of compressor station on one of Louisiana's gas transmission systems

Pipe Lines Serving Louisiana Oil and Gas Fields

Intricate system required to transport the state's yearly production of 94,368,529 bbl. of oil and 259,945,603,000 cu. ft. of gas

By FRANK H. LOVE
Managing Editor

SINCE oil was first discovered in Louisiana in 1901 in the Jennings field nearly a billion bbl. of oil has been produced. Last year the state's production was 94,368,529 bbl. Gas fields, which include Monroe, Rodessa, and Richland, to mention but a few, last year produced 259,945,603,000 cu. ft. The movement of such large volumes of production requires an elaborate network of oil and gas pipe lines in Louisiana, both in intrastate transportation as well as in the many interstate systems that originate within the state.

Oil Pipe Lines

Some of the oil lines move crude to points within the state for manufacture into motor fuel, others have as their terminals refineries in nearby states.

Gulf Refining Company, Pipe Line Division, takes oil both from North Louisiana and Gulf Coast areas. Ultimate destination is either the company's Port Arthur, Texas, refinery or the Lucas tank farm near Spindletop, Texas.

A trunk system having its origin at El Dorado, Arkansas, enters Louisiana carrying Smackover crude and picks up oil from the Haynesville, Homer, and Lisbon fields. The first station in Louisiana is at Dubberly. From here the crude oil is pumped to the Mansfield station, then across the line into Texas. From the Timpson station in Texas it is pumped southward to Port Arthur and Lucas tank farm. The daily capacity of the line between El Dorado and Dubberly is 12,000 bbl. and between Dubberly and Timpson 15,000 bbl.

Another line extends from Potter station, Louisiana, which receives crude from the Rodessa, Caddo, and Pine Island fields. The crude is pumped through the Chatterton station, to the Carthage, Texas, station, and into Timpson where it joins the stream from El Dorado. From Potter station to Timpson the daily capacity of the line is 19,000 bbl., but from there southward it increases to 28,000 bbl.

From El Dorado to Dubberly the line is an 8-in. and from there to Timpson a 6- and 8-in. looped line. The line from Potter to Timpson is a 6-in. having two 8-in. loops.

Prime movers are Diesel engines driving reciprocating pumps.

The first lines of the Gulf Pipe Line Division in North Louisiana were laid in 1907 and additions have been made since.

The South Louisiana 8-in. line owned by the above company was laid in 1912 when the Vinton field was brought in. Stations are at Hackberry, Edgerly, Starks, and Vinton. From the last point the crude oil is pumped to the Lucas tank farm in Texas.

Gulf Coast Louisiana has certain transportation problems not experienced in the northern part of the state. This is caused by the swampy condition of certain areas. In many instances it has been found practicable to lay short lines to connect with barge-loading and tanker-loading facilities. Gulf has a 6-in. line from the Evangeline field to Nezpique from which point the crude oil is shipped by barge to Port Arthur. One field station at

Evangeline is sufficient to pump the line's capacity of 6000 bbl. of crude per day. Production from Leesville, Quarantine Bay, Grand Bay, Timbalier Bay, and Hermitage Bay is gathered by a 6-in. system and also loaded onto barges for shipment.

From Louann, Arkansas, to Shreveport, Louisiana, The Texas Pipe Line Company has parallel 6-in. and 8-in. lines. From the Rodessa field, through the old Oil City production, a 6-in. line extends to Shreveport where it connects with the line from Arkansas. The parallel 6-in. and 8-in. lines continue southward to Logansport, Louisiana, and at this point cross into Texas and run southward through San Augustine, Bronson, Kirbyville, and Mauriceville to refineries at Port Arthur and Port Neches. There are stations at each of the points mentioned. Diesel engines and reciprocating pumps are used for pumping.

In South Louisiana the company has a 6-in., 45-mile line from Hazelwood to Anchorage where The Texas Company has a tanker-loading terminal. From New Iberia to Avery Island a 6-in., 11-mile line transports oil for barge loading. Production from the Lafitte field is transported by pipe line to Marerro, across the river from New Orleans, for tanker loading. The length of this line is 25 miles. A 6-in. line, 9 miles in length, extends from Garden Bay Island to Pilottown for deepwater loading.

The Standard Oil Company of Louisiana, Pipe Line Department, system ties-into the Oklahoma Pipe Line Company's line at the Louisiana-Arkansas border in the northwestern corner of the state and accepts that company's oil from Oklahoma fields for transportation. The tie-in is near Texarkana. From that point four parallel lines extend to Baton Rouge where the Standard Oil Company of Louisiana has a large refinery.

In 1937 the company laid a 6-, 8-, and 10-in. telescoped line to connect the Roanoke and Jeanerette fields on the Gulf Coast with the Baton Rouge refinery. The system consists of 46 miles of 6-in. from the Roanoke field to Sunset; a 6-in. line from the Jeanerette field to a junction point at Breaux Bridge, and an 8-in. line from this junction to Sunset. The two lines converge into a single 8-in. at Sunset, extending to a junction between Lottie and Lavonia. From there to Port Allen, a distance of 22½ miles, the line is of 10-in. pipe. The total length of this system is 150 miles.

Pumping stations are situated at Roanoke, Jeanerette, and Sunset. The Jeanerette station contains three 100-hp. vertical multi-cylinder internal

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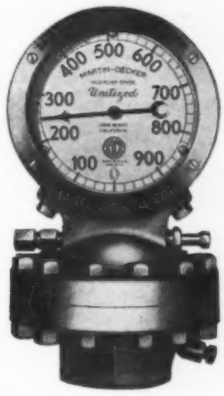

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indicates on a large, easily-read dial all variations in pressures up to 1000 pounds. Readings are distributed over 360° of dial circumference... large numerals give full visibility from a distance of more than 40 feet... and the built-in Pulsation Damper smooths the gauge hand movements and assures accurate readings. It's easy to install and remove, requires no attention while in use and insures efficient mud pressure control in all shallow drilling operations.

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combustion engines operating on natural gas. These engines drive duplex pumps. The Roanoke station contains two units of the same type. At the Sunset station are two 300-hp. twin-cylinder engines operating on crude oil and driving double-acting, triplex pumps.

The 8-in. line of the Magnolia Pipe Line Company from El Dorado, Arkansas, to Beaumont, Texas, cuts across the northwest corner of Louisiana. The first station in Louisiana is at Fitch, Webtser Parish, and succeeding stations are at Benton in Bossier Parish, Rodessa, Dixie, and Blanchard in Caddo Parish, the last station pumping into the Faulkner station in Texas. The trunk system is southward to Beaumont, but a 4-in. branch line extends from Faulkner to Bull Bayou in Red River Parish, Louisiana.

Arkansas Pipe Line Company has two 8-in. lines into Shreveport, terminating at the refinery of the Arkansas Fuel Oil Company, an affiliate. One line is from Haynesville on the north and the other from the East Texas field.

Atlas Pipeline Company also has two lines into Shreveport; an 8-in. line from the East Texas field, as well as an 8-in. line from El Dorado, Arkansas. Stations are at three points on this line: between Longview and Kilgore in East Texas, at El Dorado, and at Minden, Louisiana.

The Continental Oil Company, in 1936, laid a rather unusual system from the Tepetate field, Louisiana Gulf Coast, to Lake Charles, by placing an oil line and a gas line in the same ditch. The oil line is 6-in. in diameter and the gas line is 8-in., each about 45 miles in length. The crude oil is loaded into barges at Lake Charles and the gas is utilized for commercial purposes.

Shell Petroleum Corporation has a short line in the Gulf Coast area that transports crude from the Iowa field to loading racks on the Calcasieu River and to the Magnolia Petroleum Company's tank farm at Lockport.

Gas Pipe Lines

United Gas Pipe Line Company receives most of its gas supply from fields in North Louisiana, Monroe, Rodessa, Richland, Sligo, and others. The markets served by the system are principally in the Gulf Coast area of Louisiana and Texas.

A combination 18-in. and 20-in. line transports gas from the Monroe and Richland areas to Webster Station northeast of Shreveport. From here the gas is pumped through parallel 14- and 16-in. lines, crossing the state line southwest of Shreveport to tie-in at the Latex station of the company in Texas. From the Rodessa field three lines (12-, 14-, and 18-in.) extend southeastward to connect north of Shreveport with the line described. A single line continues on to Shreveport. From Latex station a combination 14- and 16-in. line runs southward and at Buna, Texas, branches to serve South Louisiana areas. The line extends southeastward to Franklin. At Iowa it branches and runs northeastward to Le Compte.

North of Baton Rouge is the Scotland station. Gas is delivered here from the north by the Interstate Natural Gas Company, Inc. Distribution is to New Orleans. Amite, Bogalusa, Covington, and Slidell, north of New Orleans, are served by the southern section of the United's system from Jackson, Mississippi.

Compressor stations on the Louisiana part of the system and their total horsepower are as follows: Sterlington, two stations, one having 680 hp. and one 4000 hp.; Alto station, 3200 hp.; Webster station, 3800 hp.; Elm Grove station, 1350 hp.; Iowa station, 1700 hp., and Scotland station, 6000 hp.

Interstate Natural Gas Company has 281.94 miles of pipe lines in the State of Louisiana. Of this total 177.38 miles is of 22-in. pipe, 26.81 miles is of 20-in. pipe, and 77.75 miles of pipe ranges in diameter from 10 in. to 18 in. The route of the trunk system is from Fowler, Ouachita Parish, to Baton Rouge. The DeSiard station, situated at Fowler, has 6600 hp. and the Brock station at Ferriday 7900 hp. Capacity of the line between Fowler and Ferriday is 167,000 M cu. ft. per day and between Ferriday and Baton Rouge 163,000 M cu. ft.

Operating pressures range from 320 to 360 lb. discharge and 110 to 200 lb. at the terminal.

Markets served by the system include Natchez, Mississippi, small towns along the route, Baton Rouge, Louisiana, and environs, and in addition gas is delivered to the United Gas Pipe Line Company at its Scotland station north of Baton Rouge for distribution at New Orleans.

Southern Natural Gas Company has 92.4 miles of 16-in., 18-in., 20-in., and 22-in. gas lines in the state. From Perryville, Louisiana, the line runs almost directly eastward to enter Mississippi and continue on through Alabama and into Georgia, terminating at Atlanta.

There is but one compressor station in Louisiana, at Perryville. In Mississippi stations are situated at Onward, Pickens, and Louisville; in Alabama at Reform, Tarrant, and Selma, and in Georgia at Ben-Hill. Combined horsepower of the stations is 36,900. Compressor units are 4-cycle gas-engine-driven and 2-cycle V-type engines having angle compressors. The capacity of the line is 146,000 M cu. ft. per day. Industrial and domestic markets are served. The system is about ten years old.

The first station constructed by the company is at Lewis, Louisiana, known as the Rogers station. It was built in 1911 and is still in operation. Another station, the Mills station at Rodessa, was constructed two years previously but not by Arkansas-Louisiana. It was erected by the Dawes interests of Chicago and in 1928 was acquired by the Arkansas-Louisiana Gas Company and has since been a part of its system. The Rogers station is equipped with three 1300-hp. horizontal twin-tandem, double-acting gas engines and has a capacity of 50,000,000 cu. ft. per day.

The largest station on the system is at Sterlington, Louisiana, having eight 1000 hp. engines. This station was constructed in 1930.

The stations mentioned are the only ones situated in Louisiana; others are in Arkansas and Texas.

Memphis Natural Gas Company's system consists of 211 miles of 16-in. line from Guthrie, Louisiana, in the Monroe gas field, to Memphis, Tennessee. Only a small part of this system, however, is in Louisiana. The line extends northeastward and crosses the Louisiana-Arkansas line near the town of Wilmot. The capacity of the line is approximately 45,000,000 cu. ft. per day.

The largest compressor station on the system is at Guthrie, Louisiana, having 5000 hp. Other stations are at Wilmot, Arkansas, Benoit, Mississippi, Lula, Mississippi, and Memphis, Tennessee.

Maximum operating pressure of the line is 400 lb. per sq. in.

Mississippi Valley Fuel Company has a 22-in. line originating at Perryville in the Monroe field and extending northward to St. Louis, Missouri. A compressor station is situated at Perryville. Only a short section of the line is in Louisiana as the Arkansas border is but a few miles distant.

Gasoline Pipe Line

Cities Service interests operate the only gasoline pipe line in the state. This line originates at the Arkansas Fuel Oil Company's refinery in Shreveport and extends southward to Port Arthur, Texas. Its route is partly in Louisiana and partly in Texas. Originally it was an oil line in use by The Texas Pipe Line Company, and was leased to Cities Service and revamped to convert it into a gasoline carrier.

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Aerial view of Rodessa Oil and Refining Company plant

Refineries in Louisiana Are in Step With Production

Refining-production ratio of 84 percent compares favorably with Texas'—Louisiana refining is not throttled as many believe

By H. LEE FLOOD
Associate Editor

CONTRARY to popular belief, the refining facilities in the state of Louisiana are remarkably well balanced with relation to the oil production of the state. Many have the impression that Louisiana is "behind" in refinery capacity. This impression was formed, in part, during the period in Louisiana's political history when the tax burden threatened to drive out existing refineries.

To measure the correlation between refinery capacity and daily production in Louisiana, a comparison may be made with the neighboring state of Texas.

	Refining Capacity bbl.	*Daily Production bbl.*	*Percent*
State of Texas—all parts	1,316,000	1,461,800	90.0
State of Louisiana	224,000	266,700	84.0

From the above figures, it is apparent that Louisiana's refining capacity, expressed in percent of daily production compares favorably with the same ratio in Texas. This comparison tends to offset the impression that Texas refineries have throttled Louisiana's refining advance.

The largest refinery in the state is owned by the Standard Oil Company of Louisiana. This plant, situated at Baton Rouge, has a rated capacity for processing 100,000 bbl. of crude oil per day. The refinery, one of the most complete plants of its kind in the United States, is well-balanced in all departments, including cracking and lubricant processing. The cracking equipment has a daily capacity of 55,000 bbl., utilizing the tube-and-tank liquid-phase process so well adapted to processing large quantities of cracking stock.

The only other refinery in Louisiana in which crude oil processing is carried to completion is the Arkansas Fuel Oil Company's plant at Bossier, a suburb of Shreveport. Daily crude throughput capacity is 25,000 bbl.; capacity of the tube-and-tank cracking equipment is 15,000 bbl. per day.

The northwestern corner of Louisiana in the immediate vicinity of Shreveport has the greatest concentration of individual plants. The largest of these is the plant at Bossier just described. In addition to this, there are eight other refineries in the area, the largest of which is the Atlas Pipeline Corporation's 12,000-bbl. plant at Shreveport. Total daily crude capacity of the nine plants in the Shreveport area is 70,000 bbl.

The next greatest concentration of refining plants is in the immediate vicinity of New Orleans. Total daily capacity of the three plants in this area is 51,000 bbl. Individual daily capacities are as follows: Shell Petroleum Corporation at Norco, 25,000 bbl.; Pan American Petroleum Corporation at Destrehan, 16,000 bbl.; Chalmette Petroleum Corporation at Chalmette, 10,000 bbl. The only cracking equipment is in the Shell plant, capacity of which is 15,000 bbl. per day.

A 5000-bbl. skimming plant at Lake Charles, owned by Southwestern Oil and Refining Company, Inc., is the only refinery in the southwestern part of Louisiana.

Two refineries in Louisiana are shutdown temporarily—the Atlas Pipeline Corporation's 12,000-bbl. plant at Shreveport and the Shoreline Oil Company's 5000-bbl. plant at Shoreline. All others discussed above are operating at the present time.

Catalysts and the Catalytic Process of Cracking Liquid Hydrocarbons

By RAFAEL FUSSTEIG

Choice of catalyst affects the rate and direction of the reactions, as well as the yield and character of the product

THE oil industry today is vitally interested in all pyrolysis processes, as it recognizes that they afford a means of increasing the production of the lower boiling and more valuable products that are obtained from crude oil. Numerous processes show the continued improvement of the cracking process but the perfect cracking process that will produce the maximum theoretical yield of the lower boiling valuable motor fuels has not been developed.

Theoretical and practical observations indicate that this maximum yield can be produced by using promoters, or catalysts. Catalysis is one of the most curious and interesting phenomena in chemistry, for the reason that the reactions are initiated and the velocity of reactions is regulated by the catalyst, which introduces no energy and undergoes no change during its presence in the field of chemical activity that it seemingly has induced. Usually these catalysts are inserted in the system to act upon the oil or rather to hasten the reaction of the oil particles in their molecular rearrangement, recombination, disintegration, and isomerization.

As mentioned in a previous article of this series, the cracking process consists of a splitting of the hydrocarbon nucleus accompanied by a corresponding hydrogen migration. Consequently, the small split particle is enriched with hydrogen to form a gasoline-like hydrocarbon. The other, larger parcels, losing part of their hydrogen content during the hydrogen migration, are forced to polymerize or condense into higher molecular asphalt-like hydrocarbons or even into coke. The smallest parcels, very rich in hydrogen, are split from the hydrocarbon nucleus in the form of gaseous hydrocarbons such as methane, ethane, propane, ethylene and propylene.

Consequently, the purpose of the industry is to find a method that will permit a reduction of the quantity of gas formed, as the gas fixes a large

RAFAEL FUSSTEIG

became connected with the petroleum industry in 1923 after graduation from the Deutsche Technische Hochschule, Bruenn, Germany—He has occupied various positions in the industry, principally as chemist and engineer—Is the author of two books and numerous technical articles—At present is professor of petroleum technology in the Ecole Superieure Technique et Commerciale de Paris, Paris, France.

percent of the most valuable component, the hydrogen. The amount of migrating hydrogen would increase, whereby the gasoline yield would increase and the formation of higher molecular hydrocarbons or coke would decrease. The process of cracking a hydrocarbon may be directed in different ways. If we consider the multiplicity of compounds present in the crude oil we can imagine how difficult it is to be able to guide the flow of the reactions during the cracking process.

The most important problem for the refining engineer is to find convenient factors for determining the most advantageous reaction. Many factors play an important part in the cracking reactions, the most important being the temperature during the pyrolysis. Even the smallest increase or decrease in temperature changes the intermediary reactions, resulting in the formation of quite different hydrocarbons.

In other words, each pyrolysis presents a multitude of possibilities, thermodynamics allowing predictions as to whether a specific reaction can occur. For instance, thermodynamics proves that methane, the hydrocarbon richest in hydrogen, when submitted to a suitable pyrolysis is able to form gasoline, kerosene, and even paraffin wax. It is evident that the flow of each intermediary reaction must be regulated by the use of exact temperature. As a multitude of such intermediary reactions would occur during the cracking process, it is practically impossible to complete such a process, as each intermediary reaction proceeds at its own peculiar velocity, and only a proper catalyst can regulate these reaction velocities.

The catalyst combines during the pyrolysis with the split parcel to form a complex compound. These complex compounds are then split into new parcels exhibiting activity in a particular reaction. These parcels can be converted into desired reaction products if a very small amount of energy is added. The reason for this is that the split hydrocarbon parcels are submitted to so-called atomic adsorption in the power field of the catalyst. Thus, an additive compound is formed, which being then broken at a particular carbon-carbon bond or carbon-hydrogen bond regulates the further flow of the reaction.

In other words, a catalyst contains active centers that are able to initiate this phenomenon. The materials of the catalysis are submitted to a surface stereo-chemistry, which depends upon the so-called multiple character of the active centers, these centers possessing fixed molecular directions. There are many sorts of active centers. The first is able to split the hydrocarbon into hydrogen and carbon of two or four active linkages, the second is able to cause the formation of very active $=CH_2$ radicals, the third polymerizing these labil molecules into different

types of straight chains, the fourth being able to close the polymerized $=CH_2$ radicals into naphthenic hydrocarbons, the fifth dehydrogenating the six-membered ring, etc.

Catalysis depends upon the internal structure of the catalyst. These active centers of different characteristics depend upon the quality and quantity of the nuclei and electrons. In other words, the crystallization of internal structure of catalysts plays a very important part. Many investigators have shown by means of the Roentgen-rays that the molecules of catalysts show a crystalline structure, but that after aging, the internal structure approaches the amorphous state. This indicates that the more highly developed is the crystalline structure of the molecules of a catalyst the stronger is the reaction.

Of course, the above-mentioned types cannot be obtained in the ideal form, that is, they cannot be obtained in the form that could direct exactly the proper reaction. A catalyst presents different active centers of different electron positions; the greater number of similar electron centers decides the direction of a given reaction. Thus, for instance, the polymerization of ethylene can proceed in different directions, depending on the type of catalyst. It can be polymerized into cyclohexane, then into benzol. Another catalyst is able to transform ethylene into hexylene. Certain catalysts can be chosen that polymerize ethylene into dipropargyl, methyl pentadine, or divinyl acetylene. Of course, these reactions are reversible. On the other hand, the same catalysts can be used in the catalytic pyrolysis of liquid hydrocarbons into gasoline-like hydrocarbons. Thus, a paraffinic gas-oil can be transformed by means of a proper catalyst into gasoline of aromatic hydrocarbons. Another type of catalyst can transform the same gas oil into a gasoline having an olefinic character. This gas oil can be also transformed into a gasoline rich in both olefinic and aromatic compounds by use of a catalyst having the proper active centers. Finally, the same gas oil can be polymerized into different lube oils when certain catalysts are used. Of course, each of the products requires a different quantity of heat, this being regulated by the proper electrons of the catalyst. The reason for this is that each product requires splitting of different bonds, as well as different recombinations.

There are many sorts of catalysts used in modern chemistry. This phenomenon was first observed by Doebereiner, who ignited hydrogen by means of platinum. By touching the surface of this metal, the hydrogen molecules were split into atoms in nascent state, which reacted with oxygen very rapidly, resulting in the combustion of hydrogen. Farraday was the first to use a catalyst in the chemistry of hydrocarbons. He transformed ethylene into ethane by means of platinum sponge in 1844. Further experiments of other investigators led to the conclusion that there are also other metals that activate hydrogen molecules. Although the precious metals such as platinum or palladium are able to activate the hydrogen molecules at a temperature of about 100 deg. cent., the ordinary metals stimulate reactions at higher temperatures. Thus nickel, cobalt, iron, etc., begin to act when the temperature exceeds 100 deg. centigrade.

Not only the hydrogen molecules but also the carbon atoms are activated in the power field of the catalyst. As is well known, only the carbons of two active linkages are reactive in all rearrangement and recombination processes, as they combine with the hydrogen atoms the $=CH_2$ radicals. If the pyrolysis causes the formation of carbon molecules of four active linkages, only methane, ethane, etc., can be formed, or, at best, a small yield of gasoline of paraffinic character and inferior quality will be produced.

In other words, the activated hydrogen migrates and proper active carbon atoms produce a suitable recombination and rearrangement of hydrocarbons. It results from the above that the catalysts must create a proper ratio of active hydrogen atoms to carbon atoms having two active linkages. On the other hand, formation of carbon atoms of four active linkages must be avoided because these carbons easily tend to condense to higher molecular hydrocarbons and even to coke.

Apart from the loss of yield, coke formed during the pyrolysis is objectionable as it acts also as a catalvst in further reactions, so that the desired reactions are changed, resulting in the formation of quite different products. As mentioned, there are many catalysts used in the oil refining industry. Aluminum chloride was the first, its use being proposed by MacAffee[1] in the year 1915, although the action of aluminum chloride was known long before, having been discovered by the investigators Friedel and Kraft[2] in the year 1877.

According to the patent of MacAffee, different oils can be converted into gasoline-like hydrocarbons when submitted to reaction at relatively low temperature in the presence of 5 to 20 percent of aluminum chloride. Different pressures, even vacuum, can be used in this process, indicating that the pressure is unimportant. The catalytic pyrolysis by means of aluminum chloride occurs without formation of gaseous hydrocarbons, yielding only lower molecular liquid hydrocarbons of paraffinic character and coke. The gasoline obtained in this process has a boiling range of 45 to 150 deg. cent., and a specific gravity of 0.700 to 0.740 at 15 deg. centigrade. We reach the conclusion that aluminum chloride is able to form carbon atoms of two active linkages, as well as active hydrogen atoms, so that $=CH_2$ radicals are formed in the first phase, these being then polymerized into straight-chain olefins. Simultaneously the remaining hydrogen atoms tend to migrate to these olefins, saturating them.

The method of MacAffee consists in mixing the charging stock with aluminum chloride in a shell still, and submitting them to a temperature of 260 to 333 deg. centigrade. This process must be continued until 30 percent of residuum remains in the shell-still. When a viscous mixture of aluminum chloride and an oil is being prepared better results are obtained by pumping it to the shell still when the charging stock is heated. This produces a greater gasoline yield. On the other hand, this ideal hydrogen migration causes formation of coke, which is deposited on the bottom of the shell still.

Therefore, many investigators propose to submit the distilled vapor to the action of aluminum chloride. This process causes the vapors to be rearranged and recombined and produces a better yield of lower molecular liquid hydrocarbons. In other words, the action of aluminum chloride gives better results in the vapor phase than in the liquid phase. Of course, the vapor phase can be used in the cracking of lighter oils only, such as kerosene and light gas oil, as the heavier oils poor in hydrogen atoms will cause formation of coke in the tubes, clogging them. If heavier oils are submitted to this vapor-phase process, only the lighter fractions can be brought in contact with aluminum chloride. Of course, it must be calculated which fractions possess a proper carbon-hydrogen ratio, that is, how many fractions can pass through the contact of aluminum chloride without coke deposition.

Aluminum chloride is also able to split higher molecular aromatic hydrocarbons into lower boiling aromatic hydrocarbons. Thus, xylol when submitted to the action of aluminum chloride will be converted into toluol. We see, therefore, that this catalyst can be used in the process whereby medium molecular unsaturated hydro-

(Continued on Page 122)

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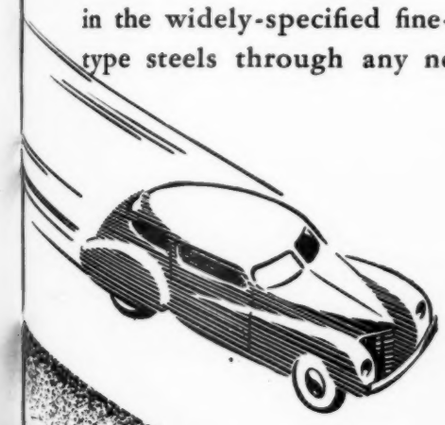

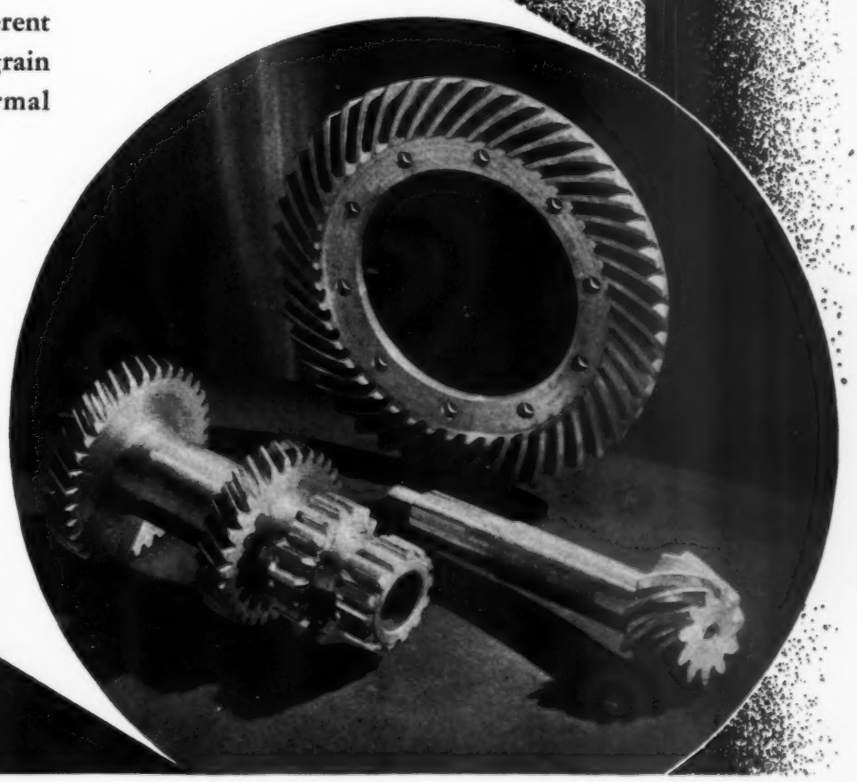

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REPUBLIC STEEL

(Continued from Page 118)

carbons of inferior quality are split into saturated lower molecular compounds.

In other words, aluminum chloride belongs to the series of catalysts having the developed hydrogenation power; that is, it is able to guide all split hydrogen atoms to migrate into the parcels that tend to form gasoline. Not only gasoline is formed from a charging oil under the action of this catalyst, however, its action being twofold. A splitting action breaks the molecules into smaller ones, and the broken molecules are synthesized into aggregates even heavier than the charging stock. The reason for this is that the $=CH_2$ radicals obtained in this process combine into a very long straight chain, thus forming a higher molecular compound. This depends to a large extent upon the contact time and temperature. Of course, it is evident that heavy oils obtained in this process are very poor in hydrogen because the greater part migrated to the gasoline parcel. According to the writer, the action of aluminum chloride can be explained on the following basis:

I. The charging stock is first rearranged into $=CH_2$ radicals and very active carbon atoms, the life of these components being very short in the field of reaction. The remaining hydrogen atoms, however, fluctuate between the active carbon atoms and the not-yet-organized gasoline parcels, their attraction being dependent upon the reaction velocities of those components.

II. The $=CH_2$ radicals polymerize into hydrocarbon chains of different lengths. This can occur in the following manner:

1. If the reaction velocity of the $=CH_2$ radicals of the unorganized gasoline of unsaturated character is great, this gasoline will absorb hydrogen atoms and become saturated. Short chains will be produced.

2. If the reaction velocity of the active carbon atoms of the active carbon chain possesses a greater attractive power than the other parcels, the hydrogen atoms will change their elastic waves, fluctuating towards the power field of the carbon atoms. The reactions that take place in splitting and synthesizing a mixture of different hydrocarbons are, of course, much more complex than in the first case. The reason for this is the fact that such carbon atoms are able to absorb different parcels on each of their linkages; for example:

$$C_nH_m + —C— + C_aH_b \rightarrow$$
$$C_nH_m = C = C_aH_b.$$

The hydrogen atoms fluctuate in elastic waves here and there, their attraction being dependent upon the reactive power of the respective components. Of course, all these fluctuations of hydrogen and carbon atoms produce different reactions of polymerization, isomerization, cyclization, etc.

Another type of excellent, very important catalysts has been used in catalytic cracking processes. It has been stated by many investigators that complex compounds of certain metallic salts, such as zinc halides and other inorganic neutral molecules, the so-called ansolvo-acids, when mixed with organic acids form catalysts of high activity. These ansolvo-acids combine with anions of organic acids to form complex anions. Consequently, the dissociation equilibrium will be displaced to the favor of hydrogen ions. Therefore, the concentration of the acids will increase. According to this phenomenon, the I. G. Farbenindustrie has found[3] that the complex compounds of antimony pentachloride + naphthoic acid, aluminum chloride + phthalic acid, sodium chloride + formic acid, etc., are excellent catalysts for the cracking of higher molecular compounds to produce a good yield of gasoline, containing mostly aromatic and olefinic hydrocarbons.

In this process a heavy charging stock is first mixed with five percent of the above-mentioned complex compounds, and the mixture submitted to a temperature of 350 to 400 deg. cent. and a pressure of ten atmospheres. This catalytic cracking produces about 45 percent gasoline rich in aromatics and olefins. It is very curious that the gasoline obtained by means of the complex compounds contains little or no trace of naphthenic hydrocarbons. This indicates that this catalyst during the action in the first phase closes six $=CH_2$ radicals into cyclohexane, this cyclohexane being then split into benzol and six hydrogen atoms.

We see that aluminum chloride contains for the most part active centers that tend to promote flow of hydrogenation reactions, whereas the complex compounds mentioned contain principally active centers that tend to promote formation of unsaturated and aromatic compounds. Thus, we can divide the catalysts used in the catalytic cracking processes into two groups: substances of catalytic hydrogenating power, such as elements of the alkali class having great atom volume, and alkaline earths, and substances of catalytic dehydrogenating power.

The first group activates the hydrogen by addition of electrons, according to the equation $H_2 + 2\bar{e} = 2H^-$; whereas the second causes the activation of hydrogen by ionization in the metallic solution, resulting in the formation of the positive ions, the so-called protons, according to the equation $H_2 = 2H^+ + 2\bar{e}$. The third possible method of hydrogen activation is the scission of the valency bond between the two hydrogen atoms without addition or removal of electrons, according to the reaction $H_2 = 2H$, but this phenomenon can be regarded as a consequence of intermediary reactions caused by the action of catalysts of the first group. Of course, the splitting of carbon-carbon bonds shows the same behavior, that is, the quantitative addition or removal of electrons in the active field of a catalyst decides the place where the carbon-carbon, carbon-hydrogen, and hydrogen-hydrogen bonds are split. In other words, each cracking process requires the use of quite different types of catalysts.

Of course, the exact knowledge of the action of catalysts permits the use of several mixtures in proper proportions. Thus in the manufacture of a gasoline of 60 percent aromatic, 30 percent olefinic, and 10 percent paraffinic hydrocarbons, a proper mixture of cobalt and alkaline earth should be used. Of course, other factors should be calculated in this process. It can easily be seen what a multitude of possibilities can be obtained, especially when considering the action of a multitude of different factors, each of which fluctuates over a wide range.

According to this conception, many propositions have been published by many investigators. Kobayashi and Yamamato[4] have found that an acid Japan clay has a strong catalytic action in the cracking of heavy oils. They state that the pressure in the cracking process can be compensated by the use of this acid clay. Thus, a heavy oil cracked at a pressure of ten atmospheres and the same oil cracked at normal atmospheric pressure but under the action of the acid clay produced the same yield of gasoline. This indicates that the microscopic channels of this clay contain in their active fields the ability of acceleration corresponding to a pressure of ten atmospheres.

Furthermore, pyrophorous chromium has been proposed[5] as a cracking catalyst of high activity. This catalyst has the ability to convert the higher molecular hydrocarbons into lower molecular aromatic compounds. Likewise the metals of the same series as molybdenum and vanadium, as well as their salts, can be used as catalysts of high activity in rearranging into aromatic hydrocarbons. The I. G. Farbenindustrie has obtained many patents[6] based on this behavior. A reaction chamber is filled with pieces of an alloy of iron-nickel-chromium. The

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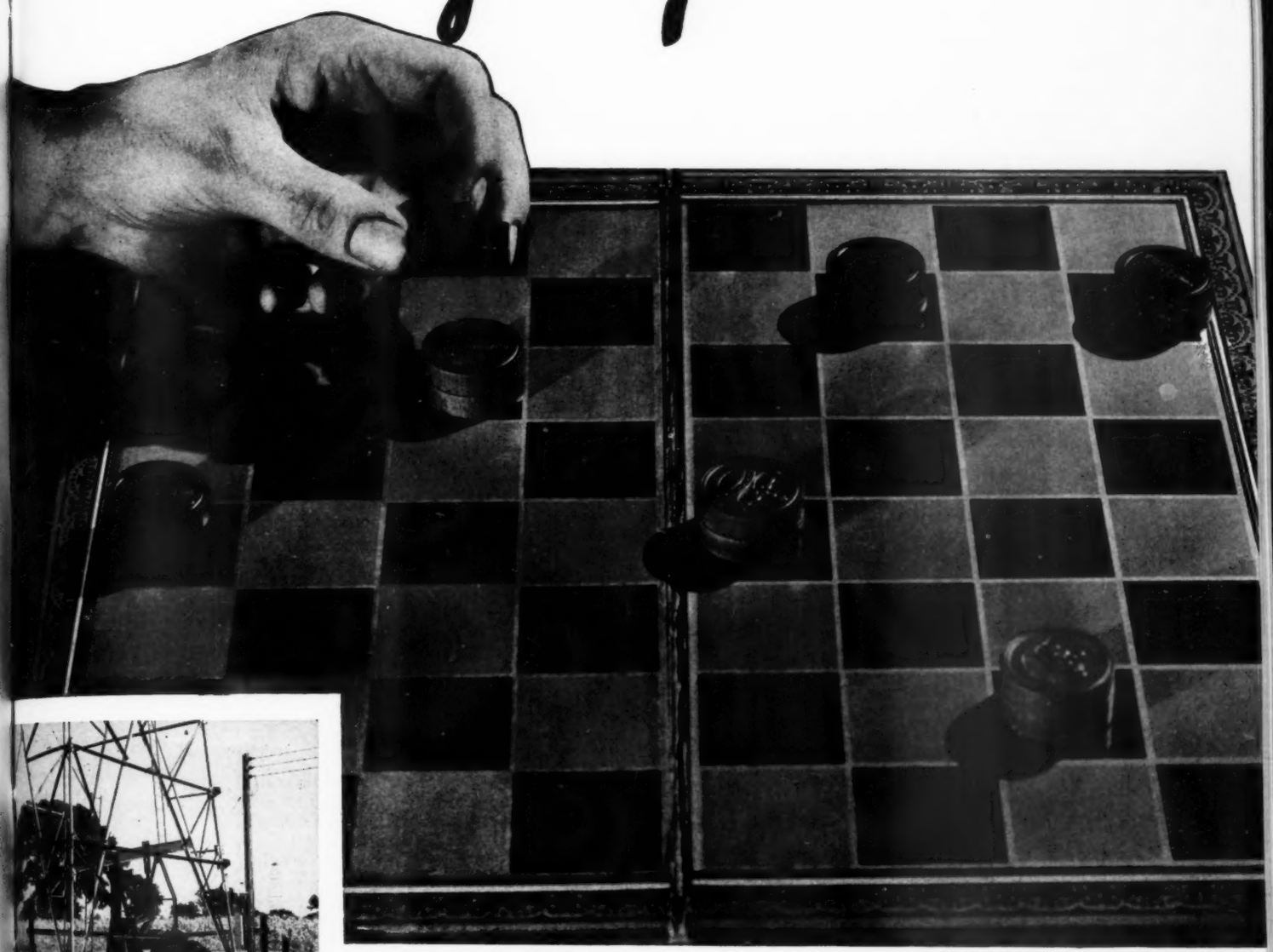

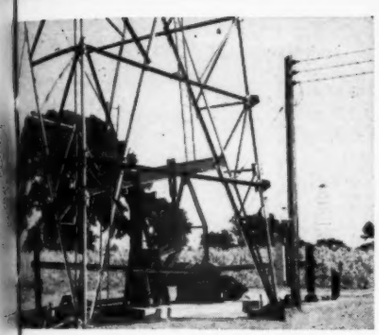

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With plenty of "king men" on the board you have many extra opportunities to "jump." And in checkers it's the extra "jumps" that count. So it is with power, too. It's the extra jumps, or advantages, that get the job done a wee bit faster, with less effort and expense, in all kinds of weather, and under every condition.

Yes, it's those EXTRA advantages that count. For example, just consider this one advantage . . . the low cost of using Purchased Electric Power. Not only is the initial investment less, but installation, operating and maintenance costs are lower. You pay only for the power used, and you use only the power needed for the job to be done.

So it's easy to see why more and more operators are turning to Purchased Electric Power. It has helped to reduce their production costs and increase their profits.

For your benefit, and for the benefit of others who haven't thoroughly investigated the advantages of Purchased Electric Power, your power company has accumulated many enlightening facts on this subject, available without any obligation on your part. So why not visit your electric power company right away. Get the facts—and be jumps ahead!

PROFIT BY USING Purchased ELECTRIC POWER

PETROLEUM ELECTRIC POWER CLUB

heavy oils are directed to this reaction chamber at a temperature of 400 deg. cent. and a pressure of ten atmospheres. As a product of the process a liquid is obtained, rich in benzol, toluol, cyclopentane, etc. Other patents propose the use of chromium oxide, chromium chloride, molybdenum oxide, molybdenum chloride, etc. Of course, to increase the activity of these catalysts it has been proposed to increase their surface by mixing them with a porous contact material such as coke, asbestos, kieselgur, or porous metal salts.

Active carbon also has catalytic properties. It is able at normal pressure to convert higher molecular hydrocarbons to lower boiling compounds when the vapors of the former come in contact with it. Of course, the temperature used in this catalytic cracking process depends on the molecular weight of the charging oil. In other words, the greater the molecular weight of the hydrocarbon the higher the operating temperature. Thus, when a charging stock of a boiling range between 200 and 300 deg. cent. is submitted to a catalytic cracking, a temperature of about 550 deg. cent. must be used. Oil of a boiling range between 250 and 350 deg. cent. requires an operating temperature of about 600 deg. cent. and a heavier oil of a boiling range between 280 and 380 deg. cent. requires a temperature of about 700 deg. centigrade. Many sorts of heavy petroleum oils, the so-called fuel oils, require even a temperature of 1000 deg. cent. when submitted to a catalytic cracking by means of active carbon. The reason for this lies in the fact that the charging oil must first be adsorbed into the microscopic channels of the active carbon, where hydrocarbons are split into the desired parcels. Each oil must have a viscosity low enough to permit adsorption. The higher the molecular weight of a hydrocarbon, however, the greater its viscosity. Therefore, hydrocarbons of greater molecular weight must be heated to a higher temperature to obtain a viscosity suitable for the catalytic adsorption. The writer dislikes to crack a heavy oil, but he recommends fractionation of this oil into fractions of smaller boiling ranges, choosing then a proper cracking temperature for each fraction.

Candea and Sauciuc[7] have cracked a Rumanian kerosene at atmospheric pressure and a temperature of 450 to 770 deg. cent. in the presence of different catalysts. These experiments led them to the observation that with increasing gasoline formation, the content of olefinic and aromatic hydrocarbons also rose. Aluminum silicate catalyst gave gasoline having a relatively large amount of aromatics. The best gasoline yield, however, was obtained using the active carbon as catalyst.

Other catalysts used in the cracking of higher molecular hydrocarbons into lower boiling compounds include chlorides and nitrates of iron, zinc, copper, etc. The "Mijnbouw en Cultuurmij" Boeton[8] treats kerosene with the abovementioned salts, 1000 cc. of oil being mixed with 250 cc. of iron chloride solution, this mixture being then submitted to a temperature of 70 to 100 deg. cent. for 15 minutes. After drying and neutralizing, the oil is distilled. The following fractions were obtained:

1. 300 cc. gasoline, boiling range 70 to 150 deg. centigrade.
2. 500 cc. oil, boiling range 150 to 250 deg. centigrade.
3. 200 cc. lube oil, boiling range 250 to 350 deg. centigrade.

Finally, the action of the iron walls of the reaction chamber plays a very important part in the cracking process. It has been stated by many investigators that the same charging stock under the same conditions gave products of different properties when cracked in two different cracking units of the same system. The reason is that the reaction chambers of these two cracking units were constructed of different types of iron. There are kinds of iron that increase the aromatization of hydrocarbons but there are also kinds of iron that produce a greater isomerization of saturated products. Moreover, it is believed that certain hydrocarbons obtained during the cracking process serve as activators one after another; these are able to divert the reaction. Of course, this depends to a large degree upon the temperature and pressure. The temperature, contact time, pressure, and catalyst play very important parts in the cracking process, as do the quality of the reaction chamber and the quality and quantity of intermediary products.

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[8]F.P. 671,035.

Industrial Use of Methane Gas in Venice, Italy, District

THE recent discovery of important deposits of methane gas in the Po Valley of Italy has kindled interest in the potential uses to which this gas may be placed. To provide the incentive for wider study and research, it was decided, at a recent meeting of the Rovigo Chamber of Commerce, to offer premiums amounting to a total of Lire 10,000 for the best reports on the industrial possibilities for the utilization of this gas.

Experiments have recently been carried out by the Venice tax collector's office in using pure methane gas as a fuel for motor vehicles. These experiments, which have extended over a period of three months, have, it is asserted, been crowned with entire success. As a test, a motor car using only methane gas was driven about an hour's run from Venice, this distance costing 21 lire, or $1.09, worth of methane gas, whereas at the prevailing local price it would have cost about 36 lire, or $1.87, to purchase eleven liters of gasoline, the amount that would have been consumed had the car used ordinary petrol, according to a statement by American Vice Consul Charles T. Terry.

In another experiment witnessed by certain officials of the railway, tramway, and automobile departments of the City of Verona, a motor boat having a type 53-A Fiat motor was operated efficiently by methane gas after some slight changes had been made in the motor to enable it to use methane gas instead of gasoline as fuel.

Running Tour
WITH MEN IN THE INDUSTRY

DR. JOHN VERNON HARRISON, for some years a member of the geological staff of the Anglo-Iranian Oil Company, and now at Oxford University, has been awarded the Gill Memorial of the Royal Geographical Society for his many years of exploration in Central and South America and in southern Iran.

BRIAN GROVER, London, England, has been made drilling engineer for the African and European Investment Company in the exploration of a large concession in Africa. He is stationed at Butiabi, Uganda.

A. POLLOCK FAICKNEY, London, England, has been elected a director of the British Burmah Petroleum Company. He also is technical director of the African Torbanite Mining and Refining Company.

D. L. HYATT, geologist, has been transferred from Ardmore to Seminole, Oklahoma, by the Carter Oil Company.

I. C. CORBELL has been made superintendent of the Tomball, Texas, gasoline plant of the Humble Oil and Refining Company. He had been assistant to the late **R. W. WAY.**

J. C. VON KERKHOFF, Shell Oil Company, is in California for a short stay. His headquarters are Amsterdam, Holland.

H. G. TEXTER, sales engineer for Spang Chalfant, Inc., is back at the Tulsa, Oklahoma, offices of the company after an extended trip to Colombia, Venezuela, and Trinidad oil fields.

H. J. MARSH, secretary of the Signal Oil and Gas Company, Los Angeles, California, has been made president of the new Southwest Exploration Company. The company was organized to develop acreage in the Huntington Beach field. **E. E. PYLES,** vice-president of the Hancock Oil Company, is vice-president and treasurer of the new company, and **R. H. GREEN,** vice-president of the Signal Oil and Gas Company, is secretary.

A. F. HOLLIDAY, Pittsburgh, Pennsylvania, president of the Hiawatha Oil and Gas Company, was a recent visitor in South Texas, where the company has holdings.

W. L. SLOAN

W. L. SLOAN, chief oil dispatcher, Gulf Refining Company, Houston Pipe Line Division, died at his home in Houston, Texas, April 16 from the effects of a paralytic stroke suffered the previous Wednesday. Sloan was one of the "old-timers" in the industry and one of the oldest men in point of service with his company. He would have completed his 36th year with Gulf the early part of next September. Sloan was with the J. M. Guffey Petroleum Company at Spindletop during the boom there. He joined the Gulf staff in 1903 as a telegrapher at the Batson station. In 1905 he was transferred to the main office, then in Beaumont, and made chief oil dispatcher, the position he has held since. **W. H. CEDERLOF,** who had been Sloan's assistant for many years, has been made chief dispatcher.

L. F. STATTON, assistant to the president, **E. P. HALLIBURTON,** Halliburton Oil Producing Company, effective April 15, accepted a position with the Arrow Drilling Company as division manager. The Arrow Drilling Company is opening offices in the Bankers Mortgage Building, Houston. **WARREN S. CHURCHILL** is president of the Arrow Drilling Company.

J. C. GORDON, assistant chief petroleum engineer of the Standard Oil Company of Venezuela, Caripito, and Mrs. Gordon, are on a vacation in the United States.

PROFESSOR HENRY PAYNE, professor of engineering at Melbourne University, Melbourne, Australia, and a director of Commonwealth Oil Refineries, Inc., is in England on a combined business and pleasure trip. He will be there for several more months and will return home via the Cape of Good Hope, South Africa, to visit friends. Professor Payne, before going to Australia, lived for some time at Cape of Good Hope.

L. G. E. BIGNELL, who has been production engineering editor of the *Oil and Gas Journal,* has been made secretary of The Engineers Club of Tulsa, Tulsa, Oklahoma, to succeed **J. H. ENGELBRECHT,** resigned.

CHARLES NEHER, district sales manager at Dallas, Texas, for 20 years for Templeton, Kenly and Company, Chicago, Illinois, passed away recently.

FRED CRABBE has been placed in charge of the Midland, Texas, territory by Manning, Maxwell and Moore, Inc., Bridgeport, Connecticut, and **CARL DAVIS** has been appointed salesman in the Houston, Texas, area.

HAROLD FAY, Oil City, Pennsylvania, and **V. G. MONROE,** Pleasantville, Pennsylvania, have been chosen producers' representatives on the executive committee of the Venango Petroleum Division of the Associated Petroleum Industries of Pennsylvania at a meeting of that organization recently.

HENRY WITTMER, Fort Worth, Texas, independent producer, has returned from a trip to South America. He was accompanied by Mrs. Wittmer.

R. D. MATTHEWS, an executive vice-president and director of the Union Oil Company of California, has resigned. He had been with the company 25 years.

J. F. DINDA, Hungarian-American Oil Company, Budapest, Hungary, who is making a two-year survey of the petroleum industry in the United States, is at present in Oklahoma.

K. B. NOWELS, who has been with the Forest Oil and Development Company at Nowata, Oklahoma, and Abilene, Texas, has resigned to open a consultant office at the latter place. He will specialize in water-flooding and other secondary recovery methods.

W. D. MORRIS has been transferred from the Rodessa field, Louisiana, to Houston, Texas, as district petroleum engineer of the Union Producing Company.

DR. V. N. IPATIEFF, director of chemical research of Universal Oil Products Company, is to receive the honorary degree of Doctor of Chemistry from the University of Sofia, Bulgaria, on May 20, during the celebration of the fiftieth anniversary of the founding of that institution. Professor Ipatieff sailed May 3 on the Normandie to receive this honor. He has also been invited by President Du Pont of the French Chemical Society to be guest of honor at a joint meeting on hydrogenation of three French chemical societies in Paris, May 24 to 28. **PAUL SABATIER,** also famous as a pioneer in hydrogenation, will be a guest as well.

W. STARRENBURG, Shell Oil Company, has arrived in California from The Hague, Holland. The trip combines business and pleasure.

JOHN P. ROBERTS has assumed his duties as assistant director of the oil and gas conservation division of the Kansas Corporation Commission, a position he held until 15 months ago, when he resigned to become assistant managing director of the Kansas Independent Oil and Gas Association.

FLOYD W. ROBSON, Tulsa, Oklahoma, has resigned from the engineering department of the Carter Oil Company to accept a post with the Jeselm Corporation, a new industrial management firm. He will serve as a member of the board of directors.

W. H. MORGAN, vice-president and general manager of the R. R. Bush Oil Company, has resigned the presidency of the California Independent Refiners' Association. **DeWITT KNOX,** secretary-treasurer of the Macmillan Petroleum Corporation, who has been vice-president of the association, succeeds him.

E. B. SHAWVER, Wichita, Kansas, president of the Kansas Independent Oil and Gas Association, and **ARTHUR DENMAN,** Sedan, Kansas, were in Washington, D.C., recently to appear at the congressional hearing on the Truman-Wheeler bill.

D. R. KNOWLTON

FRANK PHILLIPS, chairman of the board, Phillips Petroleum Company, has announced the following changes in the company's production department: **D. R. KNOWLTON,** who started with the company as petroleum engineer at Borger, Texas, in 1926, has been advanced from his position of general production superintendent to that of production manager. Knowlton will continue to make his headquarters at the Bartlesville, Oklahoma, office, where he has been since 1931, first as assistant to the chief engineer, then as chief engineer of the department, and since 1936 as general production superintendent. Phillips' production area has been divided into two regions, **J. S. MONTGOMERY** and **P. C. MURPHY** being appointed general superintendents. Montgomery, who was formerly assistant to general superintendent at Bartlesville, will be in charge of the Northern Region, which includes the states of Indiana, Illinois, Kentucky, Kansas, Oklahoma, and all of Texas except the Gulf Coast area. Murphy, formerly division superintendent of the Tri-State Division, will keep his headquarters at Houston, Texas, as general superintendent of the Southern Region. His territory includes the Texas Gulf Coast, Louisiana, Mississippi, and Arkansas. **W. J. CRITES,** chief production engineer at Bartlesville, has been appointed research engineer. **O. L. CARSON,** assistant chief production engineer, has been promoted to chief engineer. **C. P. DIMIT,** vice-president in charge of production, as well as a director and member of the executive committee of Phillips Petroleum Company, remains in active charge of the department.

M. J. CZARNIECKI, vice-president in charge of sales, A. M. Byers Company, Pittsburgh, Pennsylvania, announces the appointment of **A. D. SHEERE** as manager of the Houston division office. Sheere, formerly in Atlanta, Georgia, as assistant division manager of the Pittsburgh Division, will be in charge of the firm's oil country sales activities in the southwest. Announcement also is made of the appointment of **C. R. MacBRIDE** as manager of the engineering service department. MacBride has been transferred from the Boston division sales office to assume his new duties.

ANDREW B. AYLING, Bartlesville, Oklahoma, superintendent for 20 years of the production and pipe line department of the National Refining Company, retired May 1. He will continue to make his residence in Bartlesville.

H. A. WALLACE of Charleston, West Virginia, president of the United Fuel Gas Company and associated companies and vice-president of Columbia Gas and Electric Corporation, was appointed by Governor Holt of West Virginia to represent the state at the dedication of the Petroleum Building at the New York World's Fair on April 25.

C. F. WHALEY has been made special sales representative of the Hydril Company of Texas, having headquarters at Houston, Texas. Whaley has had broad experience in both the drilling and production divisions of the oil industry, having spent a number of years in the California and Rocky Mountain areas before coming to the Mid-Continent, where he has worked throughout the region. In recent years he has been engaged in the oil field equipment branch of the industry, having his headquarters in Houston.

ROLAND F. HODDER, engineer for George S. Mepham Corporation, who has been making his headquarters at Corpus Christi, Texas, is now stationed at Houston, Texas.

E. T. GATRELL, after 26 years' service with the Gulf Refining Company, has resigned as general superintendent of the Tulsa, Oklahoma, pipe line division. **J. N. HUNTER,** who has been assistant general superintendent, takes his place.

JOHN F. PURDUM

JOHN F. PURDUM, for the last two years manager of the machinery department of Muskogee Iron Works, has announced the establishment of a consulting engineering service in Tulsa, Oklahoma. Purdum will specialize in drilling and production methods and in the design and installation of equipment. Born in Macomb, Illinois, Purdum spent seven years in the fields of Wyoming, Kansas, Texas, Oklahoma, and Poland, working as roustabout, pumper, tool dresser, driller, and tool pusher. He then entered the Colorado School of Mines in 1925, graduating in 1930 to become research engineer for the Oil Well Supply Company. In 1932 he became chief engineer for the American Manufacturing Company of Texas, later joining Stanolind Oil and Gas Company, in charge of their equipment engineering department. He joined the M.I.W. organization in 1937.

RALPH W. COLLINS, engineer for the Stanolind Oil and Gas Company, has been transferred from Loyd, Colorado, to Elk Basin, Wyoming.

C. N. KIRKPATRICK has been elected a vice-president of the Landis Machine Company, Waynesboro, Pennsylvania, manufacturers of thread cutting equipment. Kirkpatrick will also continue as secretary of the company.

CARL A. MAPES, engineer for The Texas Company, has been transferred from Baltimore, Maryland, to Port Arthur, Texas.

F. R. OLDHAM, Houston, Texas, purchasing agent for the Gulf Oil Corporation, has resigned. He occupied that post for more than 20 years.

BERTRAND H. SNELL, York State Oil Company, New York City, visited company properties in Kansas recently.

R. SEIBEL, secretary-treasurer, and **CHARLES E. YAGER,** chief geologist, of the Texas Pacific Coal and Oil Company, Fort Worth, Texas, have been transferred from Loyd, Colorado, to Elk Basin, Wyoming.

WILLIAM C. KNEALE, superintendent, The Texas Company, is now making his headquarters at Salem, Illinois. He was at Mount Vernon, Illinois.

L. G. CAMERON, formerly a geologist with the Deep Rock Oil Company, has joined the staff of the Midstates Oil Company, Shreveport, Louisiana.

H. G. ELLIS, superintendent, Buffalo Oil Company, has been transferred from Dallas, Texas, to Wichita Falls, Texas, the company recently having acquired properties in the K.M.A. field.

Run Pipe-Lines *Faster* With Armco Pipe

Saving time and money are good reasons for running gas gathering lines with Armco Spiral Welded Pipe. It goes in fast, cuts work, and saves you money in other ways.

Transportation and handling costs are less with Armco Pipe because it is free of excess weight. Uniform lengths eliminate guesswork and make for accurate cost estimates and lower bids. Ordered in fifty-foot lengths, there are fewer sections to unload, haul and string; fewer joints to field-weld. What's more, contractors like to work with Armco Pipe because they say it welds faster and more economically.

Order Armco Spiral Welded Pipe to exactly meet your needs. Diameters range from 6 to 36 inches; wall thicknesses from 7/64 to 1/2-inch. You have a choice of standard and special fittings and optional coatings. For prices and dependable delivery promises get in touch with our nearest office. The American Rolling Mill Company, Pipe Sales Division, Middletown, Ohio; 538 Mayo Bldg., Tulsa, Okla.; 3500 Maury Street, Houston, Texas.

ARMCO

ARMCO

SPIRAL WELDED PIPE

LINE PIPE AND SURFACE CASING

LAUGH WITH BARNEY

Edited by BARNEY HORRIGAN

A Treat

Two laborers were working on a very tall block of flats. Suddenly the man at the top of the ladder called to his mate at the bottom:

"I say, Jim, come up 'ere a minute and listen."

His mate slowly climbed the ladder, and at last, quite out of breath, reached the top.

I can't 'ear nothing,"he said after listening intently for a while.

"No," said the other. "Ain't it quiet!"

The Razor

"What did you shave with this morning?"

"My wife's pencil sharpener."

He: No, I don't want to get married for a long time.

She: Who said anything about getting married for a long time?

"Joe has a glass eye."

"Did he tell you about it?"

"No, it just came out during the conversation."

The right voice for telling risqué jokes: Guttural.

Usual

"The Weavers next door are quiet tonight. Is there anything wrong?"

"No, they're always like that. When he proposed he just held up a diamond ring and said "Eh?" and she looked at it and said, "Uh-huh."

The car was moving along a lonely road. Suddenly, from under the hood came a terrific knocking. The car stopped:

He: Heck, I wonder what that knock is?

She: I think it's opportunity, baby.

A woman was on her way home from a holiday, and between trains in London dashed off a postcard to her sister.

"I hope to catch this train," she concluded hurriedly, and handed the card to a porter, asking him to post it.

When her sister got the message, it bore a neat, penciled postscript: "She caught it. Respectfully yours, Porter."

Any girl would rather be looked over than overlooked.

Daughter: Do you object to my marriage because of my youth?

Father: Yes, he's hopeless!

On Second Thought

The manager of a concern irately entered the owner's office demanding that McGraw be eliminated from the firm's personnel. To the owner's query, the manager sputtered that McGraw had insulted the owner and himself. "He told me," the manager continued, "to go fry my face and he said you could go chase yourself around the block."

Owner (testily): He did, did he? We'll fire him at once. How long has he been with us?

Manager: About five months.

Owner: What business has he done in that time?

Manager: Two hundred dollars the first month, five hundred dollars the second month, one thousand dollars the next and five thousand the next.

Owner (cogitating): We-e-l-l, maybe I ought to take a little more exercise and I dare say you could obtain a frying pan from the hardware department.

Co-operation

"How is old Bill these days?" asked one club member of another.

"Oh, he's much better since his operation," was the reply from the second member.

"Operation? I didn't know he'd had one."

"Oh, haven't you heard about it? They've removed a brass rail that's been pressing against his foot for years."

Saving Her Kisses

Old-fashioned Girl: All my life I've been saving my kisses for a man like you.

Modern Young Man: Well, prepare to lose the savings of a lifetime."

Too Soon

"Come here quick, Mandy, the baby's got something in his diaphragm!"

"Law sakes! Eff dat don't beat all —and I jes done put it on him."

Judge: You admit you drove over this man with a loaded truck. Well, what defense do you have?

Defendant: I didn't know it was loaded, Judge.

"I bet if I kissed you, you'd yell for help."

"Not unless you needed it."

Mary (spotting young man): That's the sort of man I've been looking for all my life.

Joan: Same here. But you go ahead, darling—you've been looking longer than I have!

She: What do you think I'd do if you tried to neck me?

He: I haven't any idea.

She: Aren't you curious?

"That one over there," said the keeper of the asylum, "is showing progress. We may be able to get him out soon."

"Really?" asked the visitor.

"Oh, yes. He used to think he was Louis XV. Now he only thinks he is Louis XIV."

Harrison was proud of his golf, and had brought his mother-in-law along to watch him play with a friend.

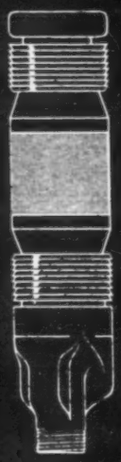
"I'm particularly anxious to make a terrific drive just now," Harrison told his friend. "There's my mother-in-law over there, and I—."

"Don't be a fool," said his friend. "You'll never hit her at 200 yards!"

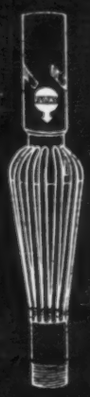
I am glad that I am not a lawyer. They have to use such involved language. Now, when a man like you, or me, gives an orange to another, all he says is: "Here is an orange" and the matter is ended. If a lawyer gives an orange, he says: "Herewith I make over to you all interest, demands, and rights of this fruit, its peel, pulp, juice and pips. You have full authority to bite, cut, squeeze or press it, or give it to a further owner, with or without peel, juice, pulp, or pips."

Up to thirty, a woman wants a man with a future; after forty, she wants a future with a man.

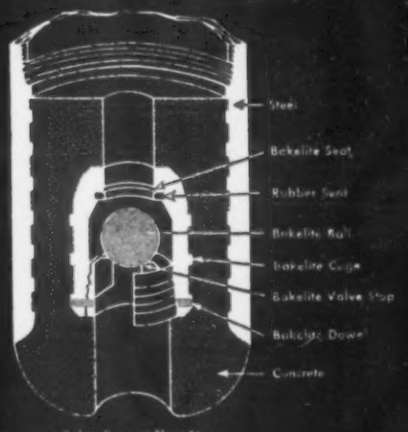
Baker Cement Wash-Down Whirler Float Shoe



Baker Model "K" Cement Retainer



Baker Cement Whirler Float Collar with Solid Bottom Baffle, with Metal "Petal" Basket



Baker Cement Float Shoe

Successful Oil Tools

ARE "DEVELOPED" NOT "DISCOVERED"

THE HISTORY of the machine age is a continuous story of discoveries . . . discoveries which opened the vistas to the remarkable period in which we now live. Discoveries, however, while tremendously important, are only the nucleus or starting point, for to be of commercial value most "discoveries" or inventions must be "developed."

It is both fortunate and unfortunate that oil tools are no exception to this rule. Fortunate because it is only through this tedious development period of trial and error that the refined product or tool can result . . . unfortunate perhaps (from the manufacturer's cost standpoint), because usually the development period continues more or less indefinitely as the result of constantly changing conditions under which the tool must operate; or requirements such as higher efficiencies which must be met.

Thus, products, such as make up the Baker Line of Oil Tools, which have been some thirty years in the development process, acquire a certain "face value" which operators have been quick to recognize and appreciate. Oil men the world over know that a tool or device bearing the word "Baker" reflects an invaluable background of accumulated experience . . . a background that results in the ability of each and every Baker tool to successfully perform the task for which it was designed.

Operating and supervising personnel, upon whose shoulders rests the bulk of responsibility for results, are doubly appreciative of this highly important background as it affords a measure of reassurance and peace of mind, the value of which is difficult to calculate in cold terms of dollars and cents.

The familiar Baker slogan "Practical and Dependable," is more than simply a play on words . . . it means just that, for to be successful, oil tools must necessarily be "practical and dependable" and practicability and dependability result from constant *development* . . . not *discovery* alone.

BAKER OIL TOOLS, INC.

P.O. BOX 71, HUNTINGTON PARK, CALIFORNIA

HOUSTON, TEXAS

MACHINERY and EQUIPMENT

Unitized Mud Pump Gauge for Shallow Drilling

A NEW model Unitized Mud Pump Gauge for pressures to 1000 lb. and especially designed for use in shallow drilling operations has been announced by Martin-Decker Corporation, Long Beach, California. Except that it has smaller capacity and does not embody the vernier-retard type movement, this compact instrument has all the features of the larger Uni-

tized Mud Pump Gauge. The dial face has been completely redesigned so that large etched numerals are distributed over the entire dial circumference. The numerals are easily read from a distance of more than 40 ft., and the built-in pulsation damper aids in smoothing-out the gauge hand movements for easy reading, yet allows instant sensitivity to the slightest pressure changes.

The instrument contains diaphragm unit, indicating gauge, and pulsation damper in one compact unit that can be quickly and easily installed or removed. It requires a minimum of attention, is unaffected by sudden fluid surges and is built to withstand the vibration of the pumps. The Martin-Decker 1000-lb. Unitized Mud Pump Gauge provides an economical and efficient method of pressure control in all slim-hole drilling operations, the manufacturer states.

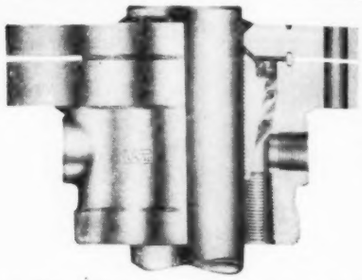
For full particulars write to Martin-Decker Corporation.

O-C-T C-7A Casinghead

OIL CENTER Tool Company, Houston, Texas, has announced a new slip type casinghead, designated as type C-7A, the design of which is said to eliminate the need for resilient packing to seal the annular space.

The accompanying cross-section drawing illustrates the method of suspending pipe and effecting seal between the pipe and the casinghead and between flanges.

After cement has set and blowout preventer equipment has been stripped-off, a split slip bowl is inserted in the body of the casinghead, stretch is taken on the casing string, and 3-segment slips are inserted to suspend the casing.

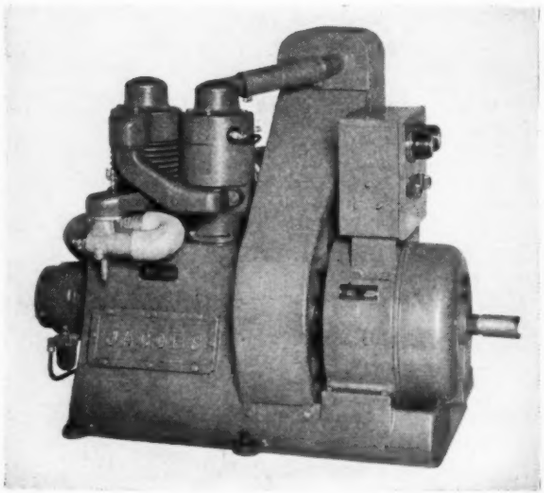


At this point, the casing is welded to the welding flange and cut off flush with the top of the flange. Thus, with an A.P.I. ring gasket between flanges, the annular space is safely sealed without the aid of resilient packing, the makers assert.

According to the manufacturer, the type C-7A casinghead is available in test pressures to 10,000 lb.

Special Cathodic Protection Unit for Pipe Lines

THE Jacobs Wind Electric Company, Minneapolis, Minnesota, has developed a heavy-duty, slow-speed engine for use in cathodic protection of pipe lines. In constructing the engine the manufacturers realized that it must operate continuously with a minimum of attention and maintenance expense. It has been designed with few working parts.

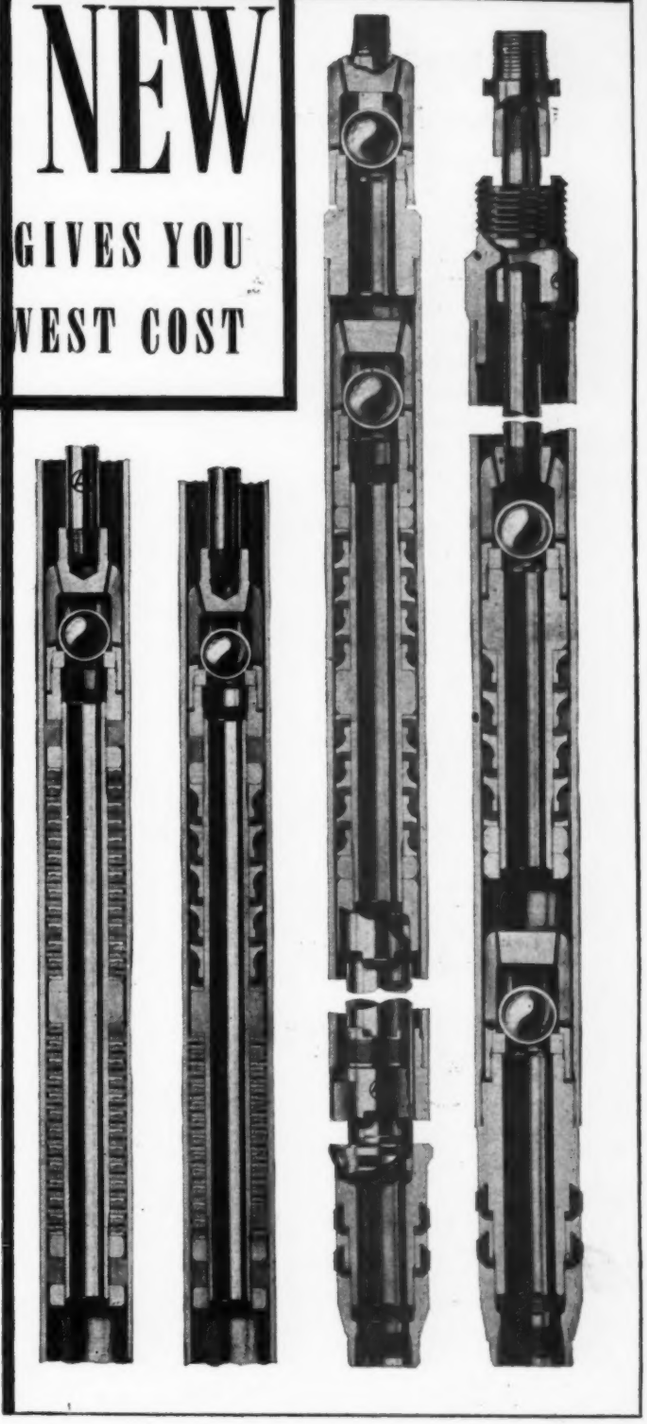


A large, heavy counterbalanced crankshaft carried on Timken bearings, two connecting rods, and two pistons constitute the principal moving parts of the unit. The armature is mounted directly on the crankshaft. The magneto is direct-driven from the opposite end of the crankshaft and is sealed in a special case. The slow operating speed of this engine of 500 to 600 r.p.m., depending upon requirements, is an important factor in its long life. It has no valves, gears, belts, pumps, or other working parts, except those mentioned above.

The radiator is so mounted as to be cooled directly from the flywheel fan and a special condenser system virtually eliminates evaporation from the radiator.

The power cylinder, operating on the 2-cycle principle, fires each revolution and because of the two-cylinder counter-balanced design, the engine has virtually no vibration. Inspection of the oil in the reserve tank and liquid in the cooling system is required only four times a year. No other attention is needed.

THIS NEW AXELSON KUP-PAK PUMP GIVES YOU QUALITY PERFORMANCE AT LOWEST COST



Axelson Kup-Pak Pumps are designed and built to give quality pump performance at lowest equipment cost in those fields where production is restricted or does not warrant the use of other type or metal-to-metal pumps. Accurately molded cups are positioned on the plunger to operate in the cold-drawn, seamless steel barrel which is actually honed in a special honing machine. Made in both stationary and traveling barrel types in all standard lengths and diameters, the plunger construction can be altered to combine cups and neoprene rings, or to use neoprene rings only. They can be installed in the top of an old barrel or with a seating nipple in the well.

Axelson Kup-Pak Pumps are ideally suited for wells in which production can be handled with packing or cup plungers. Write for Bulletin on Kup-Pak Pumps.

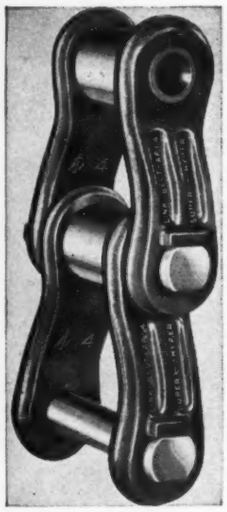
Axelson builds three complete lines of Deep Well Plunger Pumps—Standard Liner Pumps (T. S. L. & R. S. L.), Sure-Seal Pumps, Kup-Pak Pumps—to meet every pumping condition and price requirement.

AXELSON

AXELSON MANUFACTURING CO.

P.O. Box 98, Vernon Station, Los Angeles • St. Louis • 50 Church St., New York • Tulsa • *Mid-Continent and Eastern Distributor:* Frick-Reid Supply Corp. • *Rocky Mountain Distributor:* Great Northern Tool & Supply Co. • *Foreign Representatives:* "COSMOS" Soc. in Nume Colectiv, Bucharest, Roumania • *Direct Factory Representative,* Bucharest, Roumania • Industrial Agencies, Ltd., San Fernando, Trinidad, British West Indies • *Factory Representative,* Maracaibo, Venezuela • Armco International Corp., Buenos Aires, Argentina

Link-Belt Announces Super Hyper Rotary Chain



LINK-BELT Company, Indianapolis, Indiana, has developed and is now placing on the market a drop-forged side bar API-4 chain having an ultimate strength of 180,000 lb., precision-built of durable alloy steels to A. P. I. standards. It is to be known as Link-Belt Super Hyper API-4, and is announced as having the requisite qualities for combating the stresses and strains of faster and deeper drilling.

According to the manufacturer the chain has the following qualities:

1. Greater strength and freedom from distortion under very heavy load.

2. Exact chain pitch and heretofore unattained precision of bushing and chain fits, now assured by new, advanced methods of manufacture.

3. Press fits that make the assembled link an extremely rigid and durable unit.

4. Galling of chain joint forestalled, and longer chain life assured by the lubricating qualities of cadmium plating on the pins and by the smoothly ground bearing surfaces of the bushings being given a protective coating of oil before the bushings are assembled into links.

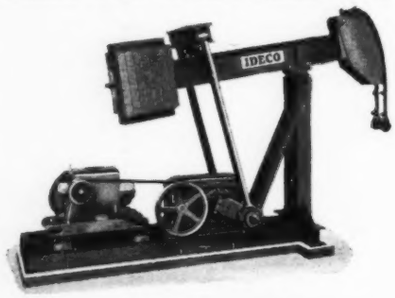
Further details of construction will be found in a new illustrated Folder No. 1713 that Link-Belt offers to send to interested readers upon request.

Ideco Unit Pumper For Shallow Wells

THE International Derrick and Equipment Company, Columbus, Ohio, has added a Unit Pumper to its line.

This new pumper is the infant of the Ideco unit pumper family. It is designed for shallow-well pumping to 2000 ft. depths. The unit is compact, measuring but 6 ft. to the top of the walking beam. Consequently, it is easily transported.

This unit is known as a DT-61. It consists of a D-18 Unit Reducer and a

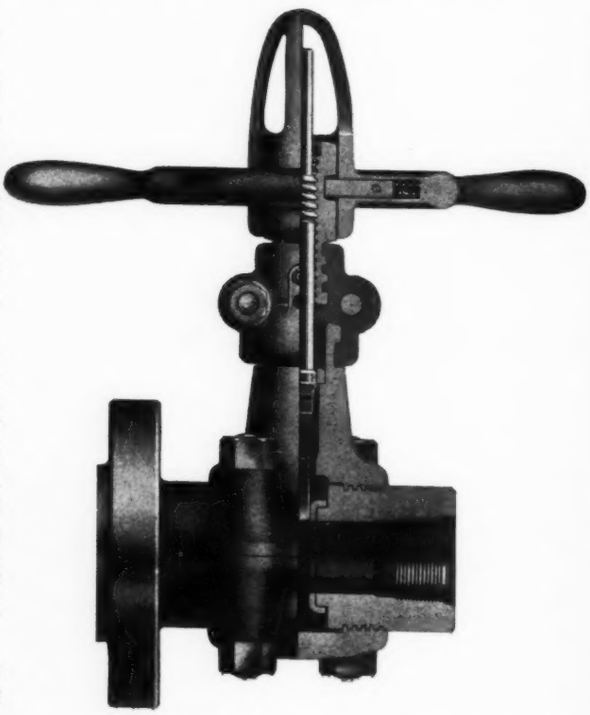


TO-H6 Unit Structure. The unit reducer is of the double reduction type, having an A.P.I. nominal capacity of 3.6 hp. at 20 s.p.m., or a peak torque capacity of 17,900 in-lb. The stroke lengths are 16 in., 18 in., 21 in. and 24 in. The reducer is equipped with heat-treated single helical gears. Gear ratio is 25 to 1. All shafts rotate in roller bearings. The reducer is enclosed in a new type Ideco solid-hub housing.

The unit structure embodies the use of twin cranks and adjustable beam weights. The samson post is of the single leg type adequately braced and is of all-welded construction. Needle-type roller bearings are used at all beam bearing points. Wrist pins rotate in tapered roller bearings. All bearings are completely sealed and equipped for pressure lubrication.

Cameron Iron Works' Flex Seal Mud Valve

AN unusual design in the new Flex Seal Mud Valve, which is equipped with a renewable resilient flow-way insert to minimize cutting and erosion, as well as to insure leakproof closure under pressure, has been announced by Cameron Iron Works, Houston, Texas.



This valve has a remarkable capacity for withstanding the destructive action of abrasive-laden fluid moving at high pressure and velocity, and for maintaining a positive shutoff, even after a long period of service, the manufacturer states.

The resilient insert absorbs the cutting action of abrasive-laden fluid at a very slow rate of wear. When worn out it may be replaced in a few minutes at low cost without removing the valve from the manifold or pipe connections by simply releasing the four body bolts and dropping the lower half of the body, it is asserted.

Hubs of the valve are connected to the body by a series of parallel shoulders and grooves that interlock with corresponding shoulders and grooves in the assembled valve body. The hubs swivel freely when making connections, permitting the valve to be used as a union in breaking down a manifold. Hubs may be fitted with threaded, flanged, welded-on, or any special connection on the outer end.

In the fully open position, the heat-treated steel gate is retracted from the flow-way. Even though the gate may be sand-cut or damaged after long service a positive shutoff is effected when it is imbedded in the insert. The valve opens and closes with ease under full rated test pressure of 6000 lb., it is said. No leverage other than that provided by the hand wheel is required to operate it under the highest working pressures, it is asserted. The valve is of the indicating stem type, clearly showing the position of the gate at all times.

B-M-W Fluid Lifter Insert Pump

THE B-M-W Fluid Lifter Insert Pump, designed and constructed for difficult pumping conditions, is the latest development by the Bradford Motor Works, Bradford, Pennsylvania. This pump has a stationary plunger and reciprocating outside tube. It is installed in and removed from the tubing with the sucker rods. When desired it is supplied with top hold-down, in which case the plunger is reciprocated in a stationary outside tube.

The plunger fitting comprises six interchangeable units. When desirable the plunger may be assembled with six sleeve units, six cup units, or six composition ring units, or with any desired combination.

Each outside tube is precise in size and selected for straightness. Every tube is individually checked and gauged for accuracy and smooth finish, and is made to close tolerances. These tubes are supplied plain or chromium plated (B-M-W Non-Kro). The hard chromium plating on the inside surface is non-corrosive and wear-resisting.

B-M-W hold-downs other than standard are available. The Lower Extension Hold-down is recommended by the manufacturer when a ball and seat is desired at the lower end of the pump. The closed cage and ball and seat are positioned within the working barrel or seating nipple. Use of this assembly reduces the possibility of the pump sanding-up, the makers assert. The B-M-W Tex-Type Hold-down can be fitted with the lower extension cage and ball and seat. The B-M-W Admore Insert Pump Anchor can be used for seating the B-M-W Fluid-Lifter Pump at any point in the tubing.

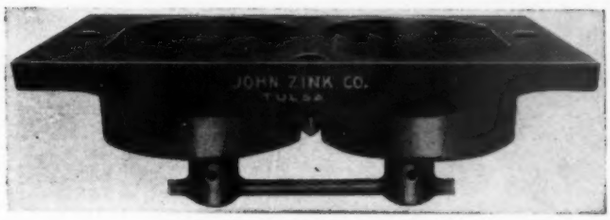
Upon request the manufacturers will supply complete information and prices.

Improved Shock Absorbers For Pumping Wells

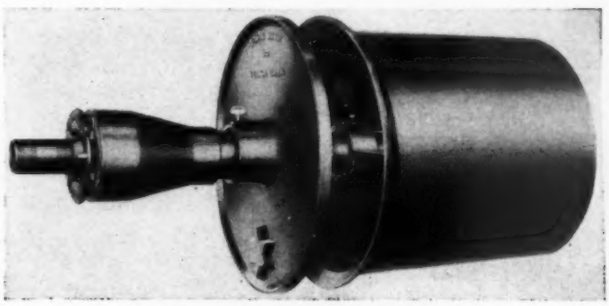
TWO shock absorbers of unusual design for use on pumping wells and pumping units are offered by Tulsa Shock Absorber, Inc., 714 South Boston, Tulsa, Oklahoma. The two models incorporate important features that reduce rod breaks and relieve strain and stress on band wheels, belts, keys, and other working equipment, the manufacturer states. The polished rod is designed to fit any type beam hanger or standard beam, and is equipped with 20 long-life rubber cushions of barrel-like shape. The beam pitman type has an oilbath bronze bearing that is reversible and interchangeable, having 14 rubber cushions, and fits any standard beam.

Both models assure smooth, easy movement in operation by eliminating "jars" and "jumpy" action, it is asserted. The rubber cushions show little wear after long periods of operation and do not heat.

TROUBLE-FREE
John Zink Bi-Mix Burners



Vertical Bi-Mix Type
For Vertical Firing of Oil Country Boilers



Horizontal Bi-Mix Type
For Horizontal Firing of H. R. T. and Watertube Boilers

John Zink Bi-Mix Burners are the only burners that burn gases of varying heat value without adjustment and are not damaged by slugs of oil, gasoline or water that sometimes blow through them from the fuel line of a gasoline plant. Practically all of the boilers in the gasoline plants in the Mid-Continent Field are fired with John Zink Burners.

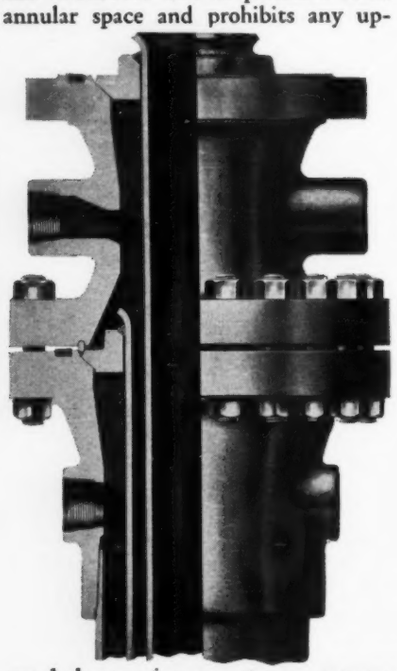
JOHN ZINK BURNERS
4401 South Peoria
Tulsa

JOHN ZINK BURNERS

TULSA . . NEW YORK
342 Madison Avenue
New York

Slip-Type Casinghead Added to Rector Line

RECTOR Well Equipment Company, Inc., Fort Worth, Texas, has announced a new slip-type casinghead, the Type "RH", which incorporates an exclusive Rector patented sealing and hold-down means. This feature, in conjunction with a steel hanger, welded or otherwise attached to casing, provides a positive, rigid, and hermetic seal of pressures from annular space and prohibits any upward thrust of casing due to extreme pressures or expansion of metals, it is stated by the manufacturers.



The Type "RH" casinghead, shown in the accompanying illustration, has a full opening through the body, has no beveled seats or other protuberances within the body to jam or be damaged by contact with tool joints or bits when drilling. Blowout preventers can be attached directly to flange of the casinghead, no spool being necessary. Any equipment of the operator's choice that is equipped with A.P.I. flanges of like series can be attached directly to these casingheads without the use of adapter spools or flanges.

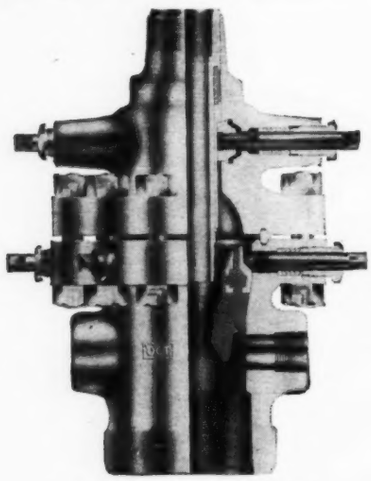
The casing is suspended on slips that do not require a slip bowl between the slips and body of head. The radial thrust caused by the weight of the casing is thus distributed evenly over a large area, the manufacturers state. The slips are of three-piece design, of special heat-treated steel. They are dowelled and grooved to assure a close fit around the casing, preliminary to their movement through the blowout preventer into their place in the casinghead.

The upper flanges of this head are provided with an auxiliary hydraulic packing, in addition to the regular A.P.I. ring groove and seal ring. The hydraulic packing is included for those operators who desire to set their blowout preventer or valves on this type of packing instead of the conventional A.P.I. packing ring. When preventer or valve is attached to casinghead flange and the inside casing set, the seal ring is utilized as a packing medium, a steel filler ring is used and later removed with the preventer or valve. This ring is not necessary after casing is set, as the auxiliary steel hanger provides this filler section.

O-C-T Tubingheads

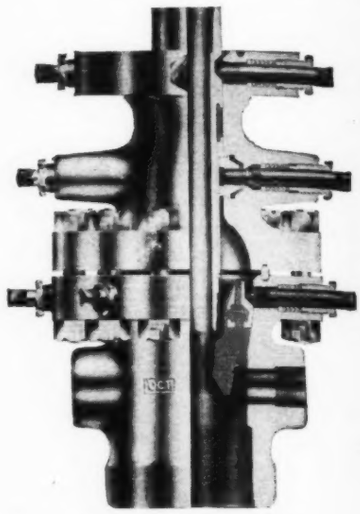
OIL CENTER Tool Company, Houston, Texas, announces two new tubingheads, both of which were designed to provide the utmost in safety and efficiency in completing wells under pressure.

The accompanying cross-sectional drawings of the Types "T-16-E" and "T-16-F" tubingheads illustrate their unusual features. Retractable hanger seats permit tubing collars and tubing hanger to pass through the head to facilitate washing behind liner and setting packer. After drilling plug and running in a few joints of tubing with liner and packer, the blowout preventer equipment is replaced by the Christmas tree, which is made up on the top tubinghead connection. The Christmas tree is stripped over the tubing and bolted down on top of an A.P.I. steel ring gasket on the body of the head. A neoprene stripper pack-off in the body of the tubinghead permits running tubing to bottom in safety, readily passing tubing collars and the tubing hanger and serving as a stuffing box when washing behind liner. After the washing operation is completed and the packer is set, tubing is then raised to the suspension point and retractable seats are screwed in to engage the tubing hanger.



Type "T-16-E" Tubinghead

Although the Type "T-16-E" tubinghead is provided with a threaded top connection, the Type "T-16-F" is provided with a flanged top that is grooved for an A.P.I. steel ring gasket. Lock-down screws are provided in the top flange to aid in compressing the hanger packing to effect a seal, whereas packing in the tubing hanger of the Type "T-16-E" is compressed only by means of the weight of the tubing string.



Type "T-16-F" Tubinghead

Both heads are made for 3000-lb. working pressure, and 6000-lb. test pressure.

Volumetric Pressure Gauge

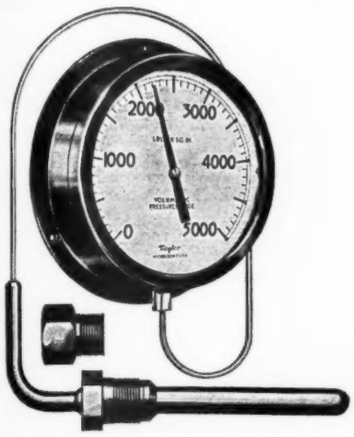
A NEW indicating and recording volumetric pressure gauge for mud pumps and cementing service and high-pressure reciprocating pumps has been introduced by the Taylor Instrument Companies, Rochester, New York.

Employing a closed system similar to a temperature tube system, the pressure-sensitive element is in direct contact with the circulating fluid. Consequently, the measuring system is instantly responsive to every pressure variation. There are no pressure taps to clog, no diaphragms to wear out; mud cannot enter the instrument mechanism, the makers state.

An inbuilt feature of this new Taylor instrument damps-out pump pulsations, yet accurately measures sustained pressure changes. This means greater ease of reading and prolonged life for the instrument, it is asserted.

Temperature variations of the fluid

have no appreciable effect on the accuracy of measurement, owing to a permanent built-in feature of the pressure-sensitive element. Changes in



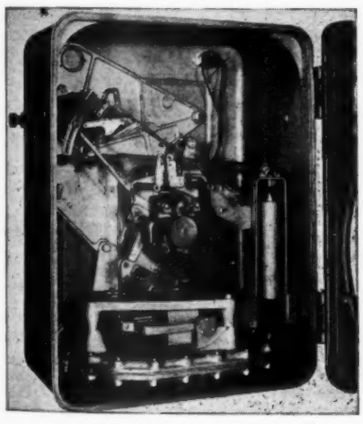
temperature along the connecting tubing are counteracted by the use of Taylor Accuratus temperature-compensated tubings, a patented Taylor product, it is stated.

The recording volumetric pressure gauge aids engineers in determining the most efficient pressure for the day's operation and gives a permanent record of the efficiency of both pump equipment and operators.

Air Flow Meter

BAILEY Meter Company, Cleveland, Ohio, announces the development of a diaphragm-operated air flow mechanism for its standard Steam Flow-Air Flow Boiler Meter.

The use of this mechanism simplifies the application of boiler meters to



Bailey Boiler Meter with Diaphragm-operated Air Flow Mechanism

steam-generating units in which excessive static draft is likely to be encountered, it is asserted. Its use makes possible air flow connections in economizers, air heaters, or boilers where excessive draft precludes the use of the usual oil-sealed air-flow mechanism.

The mechanism fits into the standard Bailey Boiler Meter, as shown in the accompanying illustration. It employs a large diaphragm that is clamped between the flanges of a metal housing. Air-flow connections from the boiler are made to this housing on each side of the diaphragm so that changes in differential pressure are measured and recorded in terms of air flow. The diaphragm is made of silk and is coated with a compound that renders it air tight and impervious to heat and moisture.

The amount of air supplied to the boiler for combustion is recorded by this mechanism and is coördinated on the boiler meter chart with the record of steam flow. When these records coincide on the 12-in. diameter uniformly graduated chart, ideal combustion conditions exist and the boiler operator can see that no adjustments to fuel or air supplies need be made.

If the rate of steam flow exceeds the air flow, a deficiency of air is recorded and to restore economical combustion the operator need only increase the air supply until the pens again coincide.

STURDY ENOUGH TO STAND THE "GAFF"

—yet compact enough to be used in limited space.

The swing to smaller and more portable drilling equipment has increased the need for McKissick Safety Traveling Blocks. Made in sizes ranging from a single sheave block with a ten-inch sheave weighing less than 100 pounds, which is especially adapted for seismograph and core drilling, to a four sheave block with 26-inch sheaves weighing almost 3000 pounds, suitable for rotary drilling in shallow fields.

McKissick Traveling Blocks are available with two, three and four sheaves.

A Complete Illustrated Folder Will Be Sent On Request.

McKISSICK
PRODUCTS CORP.
Dawson Road Phone 5-2121
TULSA, OKLAHOMA

Changes in Lane-Wells Company Organization

According to Walter T. Wells, president of Lane-Wells Company, D. S. Jeppson has been elected to the board of directors and became controller of the company April 15, 1939. Jeppson has been auditor for the company since 1933 through the firm of D. S. Jeppson, C.P.A. and Associates, and will have charge of all duties regularly designated as those of the controller.

B. G. Peters, as secretary-treasurer of the company since its organization, will continue in this position.

M. E. Montrose, formerly Gulf Coast manager of Lane-Wells, has been appointed general sales manager of the company and will make his headquarters in Los Angeles. Montrose brings to his new position a thorough knowledge of operating conditions in the Mid-Continent and Gulf Coast areas obtained during his six years' association with the company in those fields.

Morton T. Higgs, Gulf Coast sales manager, will replace Montrose as Gulf Coast division manager having headquarters in Houston, Texas, and will have charge of the company's operations in Texas and Louisiana.

P. A. Condit Joins Cooper-Bessemer

Paul A. Condit recently joined The Cooper-Bessemer Corporation to serve that organization in the capacity of

P. A. CONDIT

control engineer. With close control a very vital factor in almost every phase of modern manufacturing processes, Condit's experience and ability will be applied toward closely coördinating Cooper-Bessemer gas and Diesel engines, as prime movers, to such processes.

In the oil industry Condit has been with Pure Oil Company and Mason-Neilan Regulator Company. He was development engineer with the latter firm until he became affiliated with Cooper-Bessemer. His headquarters will be at Mount Vernon, Ohio.

Jack Mussler Manager Tubular Sales Continental Supply

Jack A. Mussler, formerly district manager in Houston, Texas, of tubular sales for The Continental Supply Company, has been appointed to the position of manager of tubular sales having headquarters at the general offices in the Continental Building, Dallas, Texas.

Mussler, who began his business career in 1923 with Continental's parent company, The Youngstown Sheet at Tube Company, was one of the first graduates of that company's training school. He early specialized in the sale of tubular products, and in 1928 was sent abroad on sales work, which took

THE STRENGTH of STEEL *Plus the* FLEXIBILITY OF RUBBER

Note the construction of Grizzly Powerflex Rotary Hose as shown in the illustration. It is this *exclusive* method of fabrication, the result of more than 20 years of experience, that gives Grizzly its superior strength and flexibility—a combination essential to long, trouble-free service.

This unbeatable combination makes Grizzly the finest, toughest and strongest rotary hose produced and is your assurance against hose failures, constant hose troubles, and frequent replacements. Use Grizzly and forget all hose troubles.

Ask your supply house about Grizzly Hose and Grizzly Couplings.

E. M. SMITH COMPANY
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Steel Armored—the finest, toughest, strongest—and yet the most flexible rotary hose ever produced.

GRIZZLY ROTARY HOSE & ROTARY HOSE COUPLINGS

him to England, France, Burma, India, Iraq, and Egypt. In the following year he traveled extensively in South America in the company's interest.

In 1930 Mussler was placed in charge of Youngstown's tubular sales in Okla-

JACK A. MUSSLER

homa and Kansas. Two years later he was transferred from Tulsa to Houston where he became district manager of tubular sales. In 1935 he joined the Continental organization in a similar capacity, which he has retained until his present appointment.

Record Attendance for Southwestern Gas Measurement Course

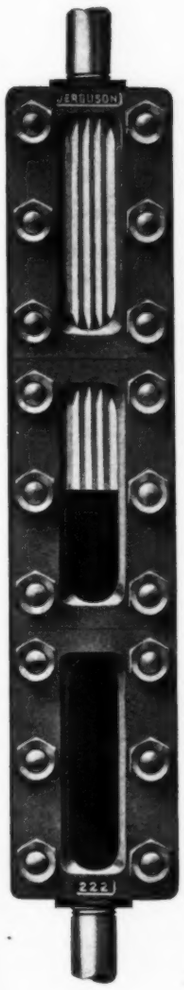
The Fifteenth Annual Gas Measurement Short Course was held at the University of Oklahoma, Norman, Oklahoma, April 18, 19, and 20. Attendance records were broken by a registration of 551, of which 66 were engineering students of the university. Washington, D. C., Mexico, and 24 states were represented.

The course is sponsored by the University of Oklahoma with the assistance of the Corporation Commission of Oklahoma, Railroad Commission of Texas, Kansas Corporation Commission, Oklahoma Utilities Association, Natural Gas Section of the American Gas Association, and the Natural Gasoline Association of America. It is directed by an Executive Committee of nine members of which Dean W. H. Carson of the College of Engineering is chairman, and conducted by the general committee of 20 members composed of representatives of the various commissions and associations and gas, gasoline, oil, and equipment companies.

Fay C. Walters, superintendent of measurement, Panhandle Eastern Pipe Line Company, was elected chairman of the general committee for the 1940 course, succeeding L. G. Rheinberger, superintendent of measurement, Sinclair Prairie Oil Company, who headed the 1939 school.

Morning assemblies were devoted to subjects of general interest and were attended by the entire enrollment. Among the speakers at the general assemblies were Dr. M. L. Wardell and Professor R. L. Huntington, of the University of Oklahoma; Glenn C. Kiley, president, Oklahoma Utilities Association; William F. Lowe, secretary, Natural Gasoline Association of America; E. H. Poe, secretary, Natural Gas Section, American Gas Association; L. K. Spink, The Foxboro Company; A. D. McLean, Pittsburgh Equitable Meter Company; Blanchard Smith, Reynolds Gas Regulator Company; Earl Kightlinger, Arkansas-Louisiana Gas Company, who reported for the committee for study of practical methods, and L. G. Rheinberger, general chairman, who presided. Papers and discussions at these assemblies included the subjects of the Fundamental Principles of Orifice Meters, Displacement Meters and Regulators, and the Behavior of Gases Under Abnormal Conditions.

JERGUSON



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SOMERVILLE MASSACHUSETTS

SPECIAL LOOSELEAF BINDER

For subscribers to THE PETROLEUM ENGINEER who find it convenient to file portions of the magazine for ready reference, we have had manufactured a special three-ring binder. It is a standard size, durable leatheroid binder with dividers for each division of the industry. The binder may be had for $1.25, express paid, by filling in the attached coupon and mailing it to us with your remittance.

THE PETROLEUM ENGINEER,
P. O. Box 1589, Dallas, Texas.

Here's my check for $1.25 for a Special Binder.

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*Title*_____

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*State*_____

Check your division:
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☐ Producing ☐ Refining
☐ Manufacturing

Flash!

Have you seen the NEW O'Bannon Tubing Tong? You should, because it's the

Strongest in grip!

Lightest in weight!

Easiest to handle!

Ask your O'Bannon representative for a demonstration on your next tubing job.

Manufactured by
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TUBING TONG

Baash-Ross Advances Bronzan and Craig

B. (LOU) BRONZAN

HARLEY CRAIG

B. (Lou) Bronzan, former assistant sales manager of the Baash-Ross Tool Company, has been appointed sales manager of the company. Bronzan, who started with the company ten years ago in the production department, will have complete charge of all sales activities, both domestic and export. His headquarters will be at Los Angeles, California.

Harley J. Craig, for 15 years with the company, has recently been made general manager of its Mid-Continent division, having headquarters in Houston.

K. B. Winstead Promoted by Oil Well Supply

K. B. WINSTEAD

K. B. Winstead, district sales manager, East Texas, North Louisiana, and Arkansas District, Oil Well Supply Company, has been appointed sales manager, Midwest Division, succeeding George A. Hays, who was recently advanced to vice-president. The Midwest Division comprises all oil and gas producing regions west of the Mississippi River, including the Gulf Coast but excluding California. Winstead will make his headquarters at the Dallas, Texas, offices of the company.

Winstead's connection with "Oilwell" dates from 1921 when he was associated with the company's Fort Worth, Texas, office. He subsequently served as store manager at Breckenridge, Texas, and then as manager of the North Texas District until 1932 when he moved to Shreveport, Louisiana, to assume charge of the East Texas, North Louisiana, and Arkansas District. Winstead has a wide acquaintanceship throughout the oil fields of the Midwest.

Special Course in Colloid Chemistry and Physics

The Department of Chemical Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts, has announced its fourth special summer program in theoretical and applied chemistry and physics of matter in the colloidal state. The program, which begins July 24 and lasts for five weeks, will be under the direction of Dr. E. A. Hauser. It will consist of lectures, round-table discussions, practical training in laboratory and research work, and is offered to men actively engaged in industry or research and to graduate students.

Technical Oil Tool Personnel Changes

PAUL DIEMER BOB SCHMIDT H. H. (PETE) PETERS

Bob Schmidt, a newcomer to the Technical Oil Tool Company, will make his headquarters in Odessa, Texas, to serve the West Texas and New Mexico territory. Schmidt replaces H. H. (Pete) Peters who has been transferred to California as representative in the Los Angeles Basin and Coastal fields.

Paul Diemer, of the same organization, will make his headquarters in Corpus Christi as the first full-time representative of the Technical Oil Tool Company in the South Texas area.

Pacific Coast District A.P.I. Elects Officers

The Pacific Coast District Division of Production of the American Petroleum Institute has elected the following officials for 1939-40:

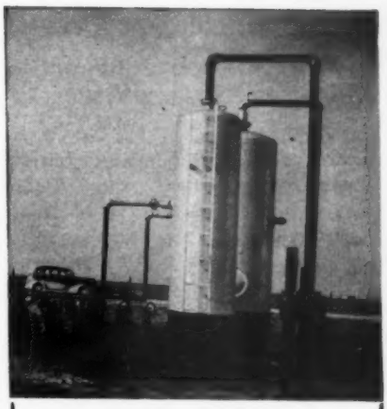
H. C. Pyle, chairman, Union Oil Company of California, Los Angeles; R. N. McMaster, vice-chairman for Los Angeles Basin, Chanslor-Canfield Midway Oil Company, Los Angeles; H. C. Stone, vice-chairman for Coastal District, The Texas Company, Santa Paula; M. W. Morris, vice-chairman for San Joaquin Valley, Standard Oil Company of California, Taft; W. G. Corey, treasurer, Pacific Gear and Tool Works, Los Angeles, and D. S. Kilgour, secretary, California Oil and Gas Association, Los Angeles.

Advisory Committee: L. L. Aubert, chairman, Bankline Oil Company, Los Angeles; Bruce Barkis, independent operator, Long Beach; A. H. Bell, Continental Oil Company, Los Angeles; E. C. Bolton, The Ohio Oil Company, Los Angeles; L. A. Cranson, Honolulu Oil Corporation, San Francisco; J. F. Dodge, University of Southern California, Los Angeles; E. G. Gaylord, Standard Oil Company of California, San Francisco; W. H. Geis, Union Oil Company of California, Los Angeles; H. P. Grimm, Bolsa Chica Oil Corporation, Los Angeles; E. B. Hall, Hall-Baker Company, Los Angeles; W. L. Heater, Baroid Sales Corporation, Los Angeles; Joseph Jensen, Tide Water-Associated Oil Company, Los Angeles; Wm. Keck, Jr., Superior Oil Company, Los Angeles; R. L. Keyes, The Texas Company, Los Angeles; W. N. Lacey, California Institute of Technology, Pasadena; M. A. Machris, Wilshire Oil Company, Los Angeles; F. A. Morgan, Richfield Oil Corporation, Los Angeles; R. C. Patterson, U. S. Geological Survey, Taft; H. C. Pyle, Union Oil Company of California, Los Angeles; E. E. Pyles, Hancock Oil Company, Long Beach; C. P. Watson, Seaboard Oil Company, Los Angeles, and H. T. Wyatt, Shell Oil Company, Los Angeles.

S.E.C. Reports on 20 Oil Refining Companies

The Securities and Exchange Commission has made public the tenth of a series of reports based on a Works Progress Administration project known as the Census of American Listed Corporations.

The report contains a summary of selected data on 20 oil refiners having producing facilities whose assets total more than $50,000,000 each registered under the Securities Exchange Act of 1934. It provides individual data for each of the companies and also combined data for all companies in each of the groups. Included in the data on individual companies are a general survey, the names of the parents and subsidiaries of each company, the outstanding security issues of each company, 16 financial and operating ratios for each company, salary data for each company, and individual balance sheets, profit and loss statements, and surplus reconciliations. The combined data for each group as a whole include a balance sheet, a profit and loss statement, a surplus reconciliation, totals of selected expense items, and 16 financial and operating ratios.



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Buy it from your supply store in container size to meet your requirements.

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- Available in a grade to meet the individual well pumping problem.
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- Fewer pulls for replacement.
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Sold thru Supply Stores

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OIL WELL PRODUCTION EQUIPMENT
TULSA

"Army" Armstrong, One of Industry's Most Prominent Figures, Passes Away

L. D. Armstrong, 52, secretary-treasurer of the Gaso Pump and Burner Manufacturing Company, Tulsa, Oklahoma, died at the Mayo Clinic, Rochester, Minnesota, on April 20, after a surgical operation for a stomach disorder. Thomas J. Flanagan, president of the Gaso company, and Michael Flanagan, vice-president, had gone with him to the clinic, remained at his bedside to the end, and escorted the remains home. Mrs. Armstrong and a daughter left for Rochester when it was learned that Armstrong's condition had become critical, but death came before they could reach his bedside.

"Army", as he was known in Tulsa and throughout the oil industry, was one of Tulsa's outstanding business, civic, and church leaders, and his friends assert that he was liked by more persons than any other one man in Tulsa. His warm, friendly personality was known to persons whose stations in life ranged from ditch diggers to millionaires. His wide popularity led to his being called into civic and social service in many capacities. He was a director of the Tulsa Chamber of Commerce, an elder in the Second

L. D. ARMSTRONG

Presbyterian Church, where he had also served as president of the men's Bible class for 14 years, a past president of the Tulsa Kiwanis Club, a director for four years of the Tulsa Community Fund, a member of the Tulsa district boy scout committee, and had recently been appointed by Grover Whalen as an Oklahoma director of the New York World's Fair. In every organization with which he was connected he had been called on for leadership. Rev. Pat Murphy, pastor of his church says of him: "I believe without doubt that 'Army' was the most beloved man in this city. He always stood at the door of our church on Sundays as official 'greeter.' He had a smile and a hearty welcome for everyone, and he rarely ever missed calling their names. His genuine interest in everyone rendered it easy for him to remember names and faces. He was a religious man in the highest meaning of the word, and a contributor to many charities."

Armstrong was born in Gainesville, Texas, and moved with his parents to Norman, Oklahoma, a few years later. He graduated from the University of Oklahoma and then entered the employ of the Wells Fargo Express Company as agent at Tulsa in 1911. Later he joined the Prairie Oil and Gas Company at Tulsa and was afterwards transferred by that company to its Independence, Kansas, headquarters.

In 1916 Thomas and Michael Flanagan, who had known Armstrong as fellow employee of Prairie, organized the Gaso Pump and Burner Manufacturing Company at Tulsa and a year

A LOW COST Measuring Line Reel!

TYPE G — for 5,000-foot wells

A low cost, sturdy, compact, measuring unit, with self-contained gasoline engine that weighs only 275 pounds, with 5,000 feet of line on the drum; two men can easily carry it. Unit will fit in back of small coupe. No changes or special mountings required. Length, 32 inches; width, 19 inches; height, 17 inches.

Capacity, 6,000 feet of 0.66 line. Ball-bearing equipped throughout. Special type clutch prevents sudden jolt on line and drum when power is applied. Besides regular combination clutch and brake the unit has an extra emergency brake.

Mathey measure meter and accessories available.

If you need a unit for measuring depths to 5,500 feet, locating fluid levels, running bottom hole pressure and temperature bombs.

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Exclusive Distributor
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for
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TUBULAR GOODS

AMERICAN PIPE & STEEL CORPORATION
Sheet and Plate Fabrication: Steel, Alloys, Aluminum
Alhambra, California

later "Army" resigned his position with Prairie to become associated with them in their manufacturing enterprise.

Armstrong was a member of the Tulsa Club, and the Tulsa Country Club, the Sales Executives' Club, the Tulsa Advertising Club, and the Men's Dinner Club of Tulsa, from all of which he will be missed. He is survived by his widow; his three daughters, Geraldine, Mrs. Carrie Louise Armstrong Todd, and Maxine; his mother, Mrs. H. W. Armstrong, of Norman, and a granddaughter, Peggy Jan Todd.

O. A. Lohrke Joins Vortox Staff

O. A. Lohrke has joined the sales staff of the Vortox Manufacturing Company, Claremont, California, and for the present is making his head-

O. A. LOHRKE

quarters in Tulsa, Oklahoma, with the company's Mid-Continent distributor, Happy Belting Company. Later, with the introduction for commercial distribution of the company's new Vortox full oil-bath air cleaner for oilfield engines and compressors, and auto trucks and tractors, he will establish offices both in Tulsa and at Dallas, Texas.

Lohrke has been a resident of Riverside, California, for a number of years, owning a hardware business at that place. Previously he had been with Allis-Chalmers Manufacturing Company, Oliver Farm Equipment Company, and Hart-Parr Company.

Mid-Continent Supply Opens New Store

The Mid-Continent Supply Company, having general offices in the Mid-Continent Building, Fort Worth, Texas, has opened a new store at Lovington, New Mexico. R. L. McAnally is store manager, working under the supervision of R. C. Tucker, district manager at Odessa, Texas.

The installation of this new branch was supervised by R. O. Moore of Fort Worth, general merchandise manager for the Mid-Continent Supply Company.

Link-Belt Acquires Speeder Machinery Corporation

Consolidation of Speeder Machinery Corporation, Cedar Rapids, Iowa, manufacturers of ⅜-yard to ¾-yard power-operated excavating and materials-handling shovels-draglines-cranes, and the Shovel Division of Link-Belt Company, has been announced by Alfred Kauffman, president of Link-Belt Company, Chicago, Illinois.

Speeder Machinery Corporation will be operated as a subsidiary of Link-Belt Company, the present management continuing to operate the business. T. M. Deal will continue as president.

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...from 500' to 6000' can be pumped more satisfactorily and economically with a JENSEN Unit or we don't want your business. A customer is no asset unless he's a booster... On that basis, are you willing to listen while we tell you what a JENSEN Jack will do in your case, and back it up with experience others have had under similar conditions? We have built pumping equipment for 20 years—it's no side line with us.. Wire us at Coffeyville or get in touch with your JENSEN dealer.

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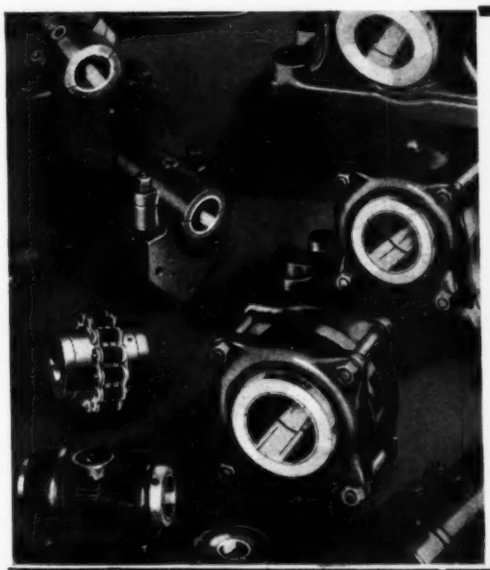

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The regulator here shown is preferable in remote, out-of-the-way places, to one of the lever type, as it protects itself against tampering or injury by weather. Its compact, light-weight design reduces handling and installation costs.

Equipped for high pressure, it reduces from 300 pounds to any desired pressure between 10 and 50 pounds.

Full information given in Bulletin 118.

Catalog on request.

The CHAPLIN-FULTON MFG. CO.
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New Appointments Made in "Oilwell" Organization

Oil Well Supply Company has announced the appointment of Russell C. Stamets, Richard F. Cann, and James R. Boax as district managers of tubular sales in the Midwest Division, which comprises all oil-producing areas west of the Mississippi River excepting California.

Stamets goes to Tulsa from Dallas, where he has been supervising tubular sales for several years. He has a wide

R. C. STAMETS

R. F. CANN

J. R. BOAX

background of experience in respect to tubular goods, having been connected with National Tube Company from 1903 until he joined the "Oilwell" organization in 1920.

Cann moves to Dallas from Fort Worth, where he has been serving as district sales manager of the North Texas District. Cann first became associated with "Oilwell" in 1923.

Boax remains at Houston, where he has been acting in the capacity of tubular sales engineer. His experience prior to his connection with "Oilwell," approximately a year ago, included several years as service and sales engineer for National Tube Company.

D. W. Sims New Head Petroleum Industry Electrical Association

D. W. Sims, Continental Oil Company, Ponca City, Oklahoma, was elected president of the Petroleum Industry Electrical Association at its convention in Houston, Texas, May 3, 4, and 5. The association, an organization of the electrical and communications branches of the petroleum industry, is composed of representatives of 24 major pipe line and oil companies.

D. W. SIMS

Sims, who served as vice-president or the organization in 1938, is superintendent of the telephone and telegraph division of Continental Oil Company. He was born in Eldorado, Oklahoma, and was graduated from Oklahoma Agricultural and Mechanical College in 1928. He joined Continental in 1930 in the pipe line accounting department, and was transferred to the telephone and telegraph division the same year. He was made superintendent of the division in 1932.

Dorsey Hager Lectures

Dorsey Hager, consulting geologist and petroleum engineer of Centralia, Illinois, delivered a talk on "Petroleum Possibilities of Illinois" before a joint meeting of United Engineering Clubs of Springfield, Illinois, held at the Hotel Abraham Lincoln, in Springfield Tuesday, April 18. The talk was illustrated with slides.

Book Reviews

Chemical Tables, from the Handbook of Chemistry and Physics. Published by Chemical Rubber Publishing Company, 1900 West 112th St., Cleveland, Ohio. 1382 pages, 1938. Price $2.50.

This is a separate book of chemical tables taken from the internationally used *Handbook of Chemistry and Physics.* It includes tables found in the handbook and many new ones, all of which have been brought up-to-date. The book is made up of tables needed daily in chemical laboratories.

* * *

Methods in Paleontology, by Charles L. Camp and G. Dallas Hanna. Published by University of California Press, Berkeley, California. 153 pp., 1938. Price $2.50.

This volume describes methods of collecting, preparing, mounting, and displaying vertebrate and invertebrate fossils. The section on micro fossils includes several methods of facilitating the separation and study of these organisms that may not be commonly known to petroleum geologists. Equipment and technique suitable for the examination of well samples are fully described.

Dowell Enters Eastern Kentucky

To keep pace with the renewed interest and activities being shown by many independent and major companies in Eastern Kentucky, Dowell Incorporated announces the reopening of their treating station at Ravenna, Kentucky.

In addition to the regular acidizing service, Dowell Incorporated offers many special services in connection with the chemical treatment of oil and gas wells, it is announced. The new Acid Jet Gun, recently perfected by Dowell Incorporated, company officials believe will find a wide application in increasing production in many of the oil wells in Estill, Lee, Powell, Owsley, Wolfe, and other producing counties in this area.

Carl A. Schacht will be in charge of the Ravenna Station and may be reached by telephone at Irvine and Ravenna or by mail at Box 175, Irvine, Kentucky.

Link-Belt Company to Get New Dallas Home

E. G. Wendell, district manager, Link-Belt Company, Dallas, Texas, announces that Link-Belt Company has contracted for the construction of a new office and warehouse building in Dallas, to be situated on Latimer Street at the intersection of Pierce Street.

The new building, to be constructed of concrete, brick, and steel throughout, will be one story in height, fronting on Latimer Street, 105½ ft. wide by 225 ft. long. An automatic sprinkler system will be installed. The office will be air-conditioned, of modernistic design, and will be at the front of the building.

Mid-Continent Supply Opens New Store

The Mid-Continent Supply Company having general offices in the Mid-Continent Building, Fort Worth, Texas, has opened a new store at Lovington, New Mexico. R. L. McAnally is store manager, working under the supervision of R. C. Tucker, district manager at Odessa, Texas.

The installation of this new branch was supervised by R. O. Moore of Fort Worth, general merchandise manager for the Mid-Continent Supply Company.

Exceptionally LONG RUNS
are obtained with the

B-M-W Tex Type Working Valve

Why? Because of the ability of the special rings to withstand wear and the cutting action of sand. As shown here, this valve is an assembly of a large number of Composition Rings separated by metal washers. In effect it is a grooved seal plunger, made from rubber and fabric, which readily adapts itself to the tube in which it works. It has the advantages of both cups and metal plungers without the disadvantages of either. It is ideal for common barrels. (For insert pumps use TEX TYPE Plunger Fittings).

In addition, 5 to 13 per cent more fluid is handled; slippage is practically nil; and you get minimum frictional drag in the tube.

Complete Information on Request.
See our advertisement in the "COMPOSITE CATALOG"

AT ALL SUPPLY STORES you can buy B-M-W Products, including: ● NEILSON Tools (Safety Sucker Rod Hooks, Tubing Hooks, Rod Elevators, Sucker Rod Sockets, etc.); ● ADMORE Insert Pump Anchors; ● BALLS AND SEATS (made for every pumping service, including the new TOWER TYPE Ball and Seat and the 2-WAY Non-Magnetic Crown); ● ADMORE Liner Barrels; ● TEX TYPE Plunger Fittings and Valves; ● COLLINS Belt Clamps; ● FLUID LIFTER Pumps; and ● NU-TEX Pumps.

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PATTERSON-BALLAGH PIPE WIPER

Wipes drill pipe
Wipes Tubing
One-piece
Reinforced rubber
Saves mud
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The hole in the center of the Pipe Wiper is slightly smaller than diameter of pipe or tubing. Being flexible it permits tool joints, protectors and coupling to pass through easily. Placed beneath the master bushing.

Style A—Adapted for all drill pipe and tubing from 2⅜" to 3½".

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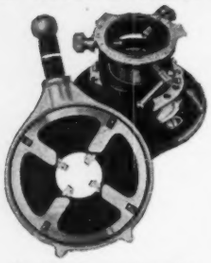
RIDGID gives you
More Speed
Easier Work
Money Saving

No. 65R-C, ratchet, cam type workholder. Users' net price complete $15.00.

in these new All-steel Malleable-alloy Threaders



No. 65R-P, ratchet, plate type workholder. Users' net price complete $14.25.

No wonder these new RIDGID No. 65R die stocks have won quick OK from you pipe tool experts. They're super-strong — even cam plates are drop-forged hardened steel. Your choice of two automatic, fully mistake-proof workholders — no bushings. They thread 4 sizes of pipe with 1 set of chasers — instead of 16 and they stay in the tool, no losing, no bother changing. Fast easy shift to size — 8 models to meet your needs. It pays you to see these new RIDGID 65Rs before you buy. For smooth, quick, perfect threading, ask your Supply House for RIDGIDs.

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Low Attractive Rates

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In HOUSTON ★ TEXAS STATE HOTEL

COMPLETELY AIR-CONDITIONED IN SUMMER

Ring Heads Eastern District A.P.I. Division of Production

D. T. Ring, Preston Oil Company, Columbus, Ohio, was elected chairman of the American Petroleum Institute's Division of Production, Eastern District, at the district spring meeting in Hotel William Penn, Pittsburgh, Pennsylvania.

The following were elected vice-chairmen: R. W. McIlvain, Jr., The Pure Oil Company, Olney, Illinois; T. H. Myers, Carnegie Natural Gas Company, Pittsburgh; J. J. Schmidt, East Ohio Gas Company, Cleveland, Ohio; J. A. Thompson, Belmont Quadrangle Drilling Company, Bradford, Pennsylvania, and O. W. Van Petten, Columbian Carbon Company, Charleston, West Virginia.

I. W. Hartman, Gordon Oil Company, Mt. Pleasant, Michigan, was elected secretary-treasurer.

A. E. Walker Becomes President Spang Chalfant, Inc.

A. E. WALKER

Alexander E. Walker, vice-president and director of The National Supply Company, Pittsburgh, Pennsylvania, has been elected president of Spang Chalfant, Inc.

Previous to joining The National Supply Company organization, Walker served the Pittsburgh Steel Company in the capacity of executive vice-president.

Walker first became affiliated with the steel industry when he joined the sales staff of the Labells Iron Works, now the Steubenville Plant of the Wheeling Steel Corporation, following his graduation from the engineering department of the University of Michigan in 1910.

In 1916 he became a salesman for Republic Iron and Steel Company, now part of Republic Steel Corporation, and in 1919 was made assistant general manager of sales. From 1928 to 1936 he served Republic Steel Corporation as general manager of sales. In 1936 Walker became president of Truscon Steel Corporation.

Extensive Technical Program for A.S.T.M. Meeting

Nearly 20 separate technical sessions will be necessary at the 1939 Annual Meeting of the American Society for Testing Materials to be held at Chalftone-Haddon Hall, Atlantic City, New Jersey, June 26 to 30, to provide for the presentation of the large number of technical papers and reports. Many of the sessions will be in the nature of round-table discussions and others will feature symposiums comprising several papers on a particular subject. Throughout the week of the meeting, there will be in progress the fifth exhibit of testing apparatus and related equipment, and also the society's photographic display, which this year will be devoted to the theme "Testing and Research in Engineering Materials."

Among the important technical features are discussions on paint testing, shear testing of soils, quantitative spectrochemical analysis, effect of subatmospheric temperatures on the properties of metals, and freezing and thawing. There will be groups of papers also covering water, fatigue of metals, asphalt, radiography, concrete, and concrete aggregates.

MEETINGS

National Association of Purchasing Agents, Annual Meeting Oil Company Buyers' Group—May 21, 22, 23, 24, and 25, Fairmont Hotel, San Francisco, California.

California Natural Gasoline Association—June 1, Richfield Building, Los Angeles, California.

Illinois-Indiana Petroleum Association, Seventh Annual Petroleum Conference—June 3, Robinson, Illinois.

Pennsylvania Grade Crude Oil Association—June 15 and 16, Hotel Hershey, Hershey, Pennsylvania.

American Society for Testing Materials, Annual Meeting—June 26, 27, 28, 29, and 30, Chalfonte-Haddon Hall, Atlantic City, New Jersey.

American Institute of Mining and Metallurgical Engineers, Regional Meeting—July 10, 11, 12, 13, 14, 15, 16, and 17, San Francisco, California.

Eastern U. S. Michigan Oil and Gas Exposition—August 1, 2, 3, 4, 5, and 6, Mt. Pleasant, Michigan.

Appalachian Gas Measurement Short Course—August 21, 22, and 23, Morgantown, West Virginia.

American Society of Mechanical Engineers—September 4, 5, 6, 7, and 8, New York, New York.

American Chemical Society—September 9, 10, 11, 12, and 13, Detroit, Michigan.

American Gas Association, Annual Convention—October 9 and 10, New York, New York.

National Safety Congress and Exposition—October 16, 17, 18, 19, and 20, Chalfonte-Haddon Hall, Atlantic City, New Jersey.

Independent Petroleum Association of America, Tenth Annual Meeting—October 18, 19, and 20, Fort Worth, Texas.

American Petroleum Institute, 20th Annual Meeting—November 13, 14, 15, 16, and 17, Stevens Hotel, Chicago, Illinois.

International Petroleum Exposition—May 18, 19, 20, 21, 22, 23, 24, and 25, 1940, Tulsa, Oklahoma.

A.P.I. Production Division Appoints Brock Chairman Waste Disposal Committee

M. E. Brock, Gulf Oil Corporation, Houston, Texas, has been appointed chairman of the American Petroleum Institute's Division of Production 1939 Committee on Disposal of Production Wastes. D. V. Stropp, Institute staff engineer, is secretary.

Membership follows: H. K. Arnold, Humble Oil and Refining Company, Houston; D. B. Dow, Indian Territory Illuminating Oil Company, Bartlesville, Oklahoma; E. M. Freeman, The Texas Company, Houston; Fritz Karge, Union Oil Company of California, Los Angeles; R. S. Knappen, Gulf Oil Corporation, Tulsa; Glenver McConnell, Shell Petroleum Corporation, Tulsa; A. S. Ritchie, McPherson Drilling Company, Wichita, Kansas; John A. Ritter, Sun Oil Company, Dallas; J. Samuelson, General Petroleum Corporation of California, Los Angeles; G. O. Suman, Tide Water-Associated Oil Company, Oil Center, California, and William F. Taylor, The Carter Oil Company, Tulsa.

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GOTT Water Coolers are the convenient way to keep drinking water handy to the worker, protect it from impurities. Their exclusive construction keeps water cool for long periods. Snug fitting large removable top, handy non-leaking push button faucet. GOTT Water Cans for handy field use. Your Supply Store has them, get one today!

GOTT WATER COOLER
Made in 3, 5, 8, 10, and 20 gallon sizes.

H. P. GOTT MFG. CO.
WINFIELD, KANSAS

KEEP PURE DRINKING WATER ALWAYS HANDY

IT SPEAKS FOR ITSELF!

"The Entirely Different Boiler and Engine Treatment"

Here is a product whose provable merit speaks more eloquently than a thousand claims! See for yourself how easy and certain it is to eliminate scale and corrosion from your boilers and engines with Sand-Banum.

Simply try this pure colloidal concentrate for 30, 60 or 90 days. If, at the end of that period, you are not entirely satisfied with results — *you pay us nothing!*

Remember, it comes in 16-ounce cans — *ready for use.* One can safely protects a 250 hp. boiler for a month regardless of the operating conditions or the nature of the water used. Arrange today for a test and know why it is "The Best!"

AMERICAN SAND-BANUM COMPANY, Inc.
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Look for the *Arm-and-Hammer*

ARMSTRONG BROS.

The Ideal Wrench

Made exclusively by ARMSTRONG BROS., truly ideal for all around uses. Jaws have two biting surfaces. Straight for pipe, "V" for fittings, valves, and narrow or irregular surfaces—takes a 2-point hold on any surface. Extended radius (rocker shape) of jaws takes up all chain slack. Jaws are drop-forged from special steel, are hardened, tempered and tested for wearing qualities. All parts are replaceable. Chains proof tested. Chains replaceable instantly with link for screwing flanges.

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